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Time2bHealthy: The efficacy of an online lifestyle behavior change program for parents of preschool-aged children

Megan Linda Hammersley
University of Wollongong

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Time2bHealthy: The efficacy of an online lifestyle behavior change program for parents of preschool-aged children

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Certification

I, *Megan Linda Hammersley*, declare that this thesis is submitted in partial fulfilment of the requirements for the conferral of the degree *Doctor of Philosophy*, from the University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

Megan Linda Hammersley

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Abstract

Background: eHealth childhood obesity treatment and prevention programs have shown promising results in facilitating behavior change, but there has been a lack of parent-focused studies and those that have included younger children.

Aim: The aim of this thesis was to investigate the efficacy of the *Time2bHealthy* online program in facilitating behavior change among preschool-aged children who are overweight, or at risk of becoming overweight.

Methods: A systematic review and meta-analysis on eHealth parent-focused childhood obesity prevention and treatment interventions were conducted and gaps in the literature were identified. A randomized controlled study was then designed, implemented and evaluated to test the efficacy of the *Time2bHealthy* online healthy lifestyle program for parents of 2-5 year old children. Parent/carer and child dyads were recruited from areas of New South Wales and Victoria, Australia between 2016 and 2017 and randomized to an intervention or comparison group. The intervention consisted of an 11-week online healthy lifestyle program and participants then received fortnightly emails for the following 3-months. Participants also had access to a closed Facebook group. Comparison participants were sent emails with links to information on similar topics. The primary outcome assessed was child body mass index (BMI). Secondary outcomes included child dietary intake, physical activity, screen-time, sleep, child feeding, parent modelling and self-efficacy. Data were collected at baseline, 3- and 6-months by data collectors blinded to group allocation. Following the collection of baseline measures, randomization was conducted using a computerized random number generator. A process evaluation of the *Time2bHealthy* online program was conducted to test user acceptance. Outcome data were further explored to investigate if change in child BMI at 6-months post-baseline was moderated by demographic characteristics or mediated by changes in obesity-related variables at 3-months post-baseline. Finally, the effect of engagement in the Facebook group on the primary and secondary outcomes was assessed by using a high and low engagement definition to categorize participants.

Results: Eighty-six parent/carer and child dyads were recruited to the trial in six cohorts. A retention rate of 91% was achieved, with 78 dyads attending the 3- and 6-month follow-ups. Seven participants were lost to follow-up and one withdrew from the trial. The mean child age was 3.46 years and 91% of children were in the healthy weight range. The intention-to-treat analyses found no significant change in child BMI between groups. Compared to children in the comparison group, those in the intervention group reduced their frequency of discretionary food intake (estimate -0.360, 95% CI -2.272 to -0.447, *P*=0.004), and parents in the intervention group improved their child feeding pressure to eat practices (-0.304, 95% CI 0.061 to -0.003, *P*=0.048) and parent self-efficacy (nutrition) (0.429, 95% CI 0.096 to 0.763, *P*=0.012) compared to those in the comparison group. There were no significant group by time interactions for other outcomes. The process evaluation indicated a high level of user acceptance. The mediation and moderation exploratory analyses found that there were no significant mediators or moderators of child BMI change in the models that were tested. Most intervention participants joined a Facebook group and the majority moderately engaged in their group. There was no significant difference in BMI change between the participants who highly engaged in Facebook compared to participants who had a lower level of engagement. Positive outcomes were demonstrated for parents who highly engaged in Facebook compared to those who had a lower engagement level in relation to percentage sedentary time (estimate -2.972, 95% CI -5.714 to -0.230, *P* 0.035) and sleep duration (estimate 0.401, 95% CI 0.031 to 0.771, *P* 0.035) of their child. There was a significant group by time interaction in relation to kilojoule intake per kg of body weight in the non-hypothesized direction (estimate 86.824, 95% CI 22.136 to 151.512, *P*=0.010).

Conclusion: This thesis provides an important contribution to the literature on eHealth parent-focused childhood obesity interventions. The *Time2bHealthy* randomized controlled trial demonstrated that a parent-focused eHealth childhood obesity prevention program did not demonstrate a difference in child BMI between groups, but did facilitate improvements to dietary-related practices and parent self-efficacy. The program content and mode of delivery were also well accepted by parents. The null findings in relation to child BMI change between groups was possibly due to most children in the sample being in the healthy weight range. It is recommended that future studies include a larger sample size and longer follow-up period. Potential scalability and translation of the program into the community should also be explored.

Statement of thesis style

This doctoral research has been presented as a thesis by compilation as agreed with my supervisors. This research has resulted in five journal articles (two of which have been published and three currently under review with peer-reviewed journals). Each of the journal articles have been presented as a chapter of the thesis. Additional information or discussion has been added to the beginning and/or end of the articles where required to ensure that the thesis flows coherently. American English spelling has been used throughout the thesis, aligning with the requirements of most of the journals.

List of publications from this thesis

Published

Chapter 2

Hammersley, M.L., Jones, R.A., & Okely, A.D. (2016). Parent-focused childhood and adolescent overweight and obesity eHealth interventions: A systematic review and meta-analysis. *Journal of Medical Internet Research* 18(7). doi: 10.2196/jmir.5893 (**Appendix B**)

Scopus citations = 12

Chapter 3

Hammersley, M.L., Jones, R.A., & Okely, A.D. (2017). *Time2bHealthy* – an online childhood obesity prevention program for preschool-aged children: A randomised controlled trial protocol. *Contemporary Clinical Trials*. 61:73-80. doi: 10.1016/j.cct.2017.07.022 (**Appendix C**)

Scopus citations = 2

Submitted for Publication

Chapter 4

Hammersley, M.L., Okely, A.D., Batterham, M.J., & Jones, R.A. *Time2bHealthy* – an internet-based childhood obesity prevention program for parents of preschool-aged children: outcomes of a randomized controlled trial. *Journal of Medical Internet*

Research (under review).

Chapter 5

Hammersley M.L., Okely A.D., Batterham, M.J., Jones, R.A. Investigating the mediators and moderators of body mass index change in the *Time2bHealthy* childhood obesity prevention program for parents of preschool-aged children. *Childhood Obesity* (under review).

Chapter 6

Hammersley, M.L., Okely, A.D., Batterham, M.J., Jones, R.A. Can parental engagement in social media enhance outcomes of an online healthy lifestyle program for preschool-aged children? *Journal of Communication* (under review).

Conference presentations in support of this thesis

Hammersley, M.L., Jones, R.A., Okely, A.D. (2015). Parent-focused childhood overweight and obesity eHealth interventions: a systematic review and meta-analysis. *Early Start Conference*, University of Wollongong, Australia 2015 (Poster).

Hammersley, M.L., Jones, R.A., Okely, A.D. (2016). Parent-focused childhood overweight and obesity eHealth interventions: a systematic review and meta-analysis. *Australia & New Zealand Obesity Society Annual Scientific Meeting,* Brisbane, Australia 2016 (Oral poster presentation).

Hammersley, M.L., Jones, R.A., Okely, A.D. (2017). *Time2bHealthy*: an online healthy lifestyle program for parents of preschool-aged children. *World Congress on Public Health*, Melbourne, Australia 2017 (Oral presentation).

Hammersley, M.L., Jones, R.A., Batterham, M.J., Okely, A.D. (2018) Efficacy of an online healthy lifestyle program for parents of preschool-aged children: results of a randomized controlled trial. *International Society of Behavioral Nutrition and Physical Activity Annual Meeting*, Hong Kong 2018 (Oral symposium presentation).

Other publications (2015-2018)

Okely, A.D., & Hammersley, M.L. (2017). School-home partnerships – the missing piece in obesity prevention. *The Lancet Child & Adolescent Health*. Published online November 28, 2017.

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**Joint first author*

Dedication

This thesis is dedicated to my wonderfully supportive family who have allowed me to pursue my dreams; my husband Paul and precious children Joel and Michaela as well as my Mum and Dad, who supported me through my previous degrees.

In memory of my dear Mum, Marie Shaw, who believed in me and gave me the confidence that I could achieve my ambitions. Sadly, she missed the submission of this thesis by only a few weeks. I will be forever grateful for her love and support.

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I have long aspired to pursue a PhD and it is with great pride that I have managed to get to the end of this challenging and very rewarding journey. This was definitely not a solo feat and there are many people that I need to thank who have helped, guided and supported me along the way.

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I would like express my deepest appreciation to my husband Paul and our precious children Joel and Michaela for enabling me to pursue my ambitions and standing by my side every step of the way. I am deeply grateful for the love and encouragement that you have given me always, and in particular during the last 3 ½ years. At times, it has been a bumpy road and I could not have done it without your unwavering support. My heartfelt thanks to my dear Mum and Dad who have always encouraged me to pursue my dreams and supported me through my earlier degrees. I would also like to offer a special thanks to my Mother and Father-in-law, Beth and Michael, who have also been great supporters.

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List of Abbreviations

BMI	Body mass index
CHO	Carbohydrate
CI	Confidence interval
F&V	Fruits and vegetables
IVR	Interactive voice response
kJ	KiloJoules
PA	Physical activity
RCT	Randomized controlled trial
SB	Sedentary behavior
SD	Standard deviation
SSB	Sugar-sweetened beverages
WC	Waist circumference
WHO	World Health Organization

Chapter 1

General Introduction

1.1 Background

Childhood overweight and obesity has been increasing since the 1970s and while it now seems to have plateaued – albeit at a higher rate, it continues to be a significant public health issue (Australian National Preventive Health Agency, 2014). There are approximately 170 million children worldwide who are overweight or obese (World Health Organization, 2012).

Overweight and obesity in children is associated with a range of short- and long-term health consequences. It is concerning that many health problems such as obstructive sleep apnea (Kohler et al., 2009), asthma, (Egan, Ettinger, & Bracken, 2013) liver disease (Reilly 2008) , metabolic syndrome (Li, Ford, Zhao, & Mokdad, 2008; Reilly, 2008), Type 2 Diabetes (Australian Institute of Health and Welfare, 2014), musculoskeletal disorders (Paulis, Silva, Koes, & van Middelkoop, 2014) and development of cardiovascular disease risk factors (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007) are now prevalent at higher rates among children who are obese. Children with obesity may also experience teasing, bullying and low self-esteem (Buttitta, Iliescu, Rousseau, & Guerrien, 2014). Overweight children have at least twice the risk of remaining overweight into their adult life compared to children in the healthy weight range (Luttikhuis et al., 2009). Obesity is more likely to continue into adulthood when it is severe and when at least one of the child’s parents is obese. It has been estimated that obesity will continue into adulthood in more than 60% of obese children (Reilly 2009). Obesity-related health problems in adults are likely to be more severe when obesity has been established in childhood rather than developing in adult years (Bass & Eneli, 2015).

Childhood obesity at a basic level results from an imbalance of food intake and physical activity and the underlying causes of this imbalance are multifactorial, including environmental and individual factors. The current environment has been described as obesogenic (or obesity promoting) (Egger & Swinburn, 1997; Weihrauch-Bluher et al., 2018; World Health Organization, 2017) with many changes occurring over a number of years, including the increased accessibility of processed foods which are high in kilojoules, saturated fat, salt and sugar and increased portion sizes, while fresh whole foods, during this same time, have become more unaffordable for many families (National Health and Medical Research Council of Australia, 2013). Other environmental factors such as more time being spent in sedentary activities, the built environment not being conducive to physical activity, poorer quantity and quality of sleep (National Health and Medical Research Council of Australia, 2013), safety of outdoor environments (Côté-Lussier, Mathieu, & Barnett, 2015), parents working longer hours (Courtemanche, Tchernis, & Zhou, 2017) and housing density (Giles-Corti, Ryan, & Foster, 2012) may also be implicated.

Early childhood is a crucial stage of life, where the foundations for nutrition and physical activity habits are formed and unhealthy behaviors such as consumption of energy-dense and nutrient-poor foods and beverages, physical inactivity and high levels of sedentary behavior are established (National Health and Medical Research Council of Australia, 2013b), (Yavuz, van Ijzendoorn, Mesman, & van der Veek, 2015). Effective weight management interventions focusing on key behavioral and environmental factors can reduce the likelihood of childhood overweight and obesity continuing into adulthood. Improving physical activity and eating behaviors are recognized cornerstone weight management strategies (National Health and Medical Research Council of Australia, 2013). There is also increasing evidence regarding the importance of limiting screen-time (Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012), reducing sedentary behavior (Okely & Jones, 2011; Okely et al., 2012; Reilly, 2008) and maintaining adequate sleep patterns (Cappuccio et al., 2008; Miller, Kruisbrink, Wallace, Ji, & Cappuccio, 2018; Wu, Gong, Zou, Li, & Zhang, 2017).

During early childhood, parental influence and role-modelling play a key part in the development of healthy behaviors, making the positive influence of parents at this stage vitally important (Golley, Hendrie, Slater, & Corsini, 2011; Natale et al., 2014; Niemeier, Hektner, & Enger, 2012). The role of parents in shaping positive health behavior habits is central to changing the course of childhood obesity (Gruber & Haldeman, 2009; Ventura & Birch, 2008). The current Australian National Health and Medical Research Council Clinical Practice Guidelines for the Management of Overweight and Obesity highlight the importance of parent involvement in childhood weight management interventions and the potential for the use of family-based goal setting which incorporate plans for overcoming barriers to behavior change. Furthermore, it has been found that interventions targeting children younger than five years that are home-based or in a health care setting are the most effective, perhaps due to the higher level of parental engagement in these settings compared with educational settings (Ho et al., 2012; Luttikhuis et al., 2009; Waters et al., 2011).

The importance of parental involvement in childhood obesity behavior change interventions has been highlighted in systematic reviews (Ho et al., 2012; Luttikhuis et al., 2009). In these, few studies focused on preschool-aged children (Luttikhuis et al., 2009), which is arguably the most important age for parental involvement (Ho et al., 2012). A recent systematic review and meta-analysis of parent-focused obesity prevention and treatment interventions in early childhood (0-6 years) reported that when successful studies were looked at individually, the five that were successful in the long-term all commenced during preschool age (3-5 years). The meta-analysis of the pooled studies demonstrated a small, yet significant combined effect in the short-term, but in the long-term, the combined results were not significant (Yavuz, van Ijzendoorn, Mesman & van der Veek, 2015). These results suggest that intervening at a younger age may produce more favorable outcomes in the long term.

While healthy lifestyle education is crucial, there are significant barriers for families in implementing changes, highlighting the need for programs that aim to facilitate and overcome barriers to lifestyle behavior change (Gruber & Haldeman, 2009). Interventions which utilize joint dietary, physical activity and behavioral strategies have been shown to be the most effective in preventing and treating existing childhood obesity (Ho et al., 2012; Luttikhuis et al., 2009; Waters et al., 2011). Effective broad-reach interventions that target childhood are required; and while it has been established that parental involvement appears to be critical, there is currently no consensus on other intervention components (Luttikhuis et al., 2009). A recent systematic review investigating obesity interventions in children suggested that successful programs incorporate components such as skill building, behavior change strategies, social networking and information on resources in the community. It was also suggested that future studies investigate eHealth modes of delivery in the 0-5 age group, as such interventions have shown promise in older age groups (Laws et al., 2014).

The use of the online medium for healthy lifestyle programs offers advantages compared to face-to-face programs in regard to convenience and accessibility. Barriers associated with traditional delivery methods such as travel time, cost, child-care and committing to regular appointments/sessions (Warren et al., 2007) can be negated with the use of a technology-based medium. Time constraint issues are particularly notable for parents of preschool-aged children who may have busy schedules due to work commitments, child activities, caring for other children and maintaining nap and feeding routines. Components of face-to-face programs can to some extent be replicated online through the use of videos, online guided goal setting, use of email to communicate and ask questions and the use of social media to create an online community. Therefore, a flexible online-based program for parents of this age group has the potential to offer similar advantages to a face-to-face program while overcoming barriers and maximizing participation.

There have been an increasing number of online healthy lifestyle programs for children and/or parents in recent years (An, Hayman, Park, Dusaj & Ayres, 2009; Nguyen, Kornman, & Baur, 2011). Previous reviews have investigated the impact of technology-based overweight and obesity interventions in childhood and adolescence with some studies reporting changes in adiposity, dietary and/or physical activity outcomes (An et al., 2009; Nguyen et al., 2011). Evidence indicates that carefully targeted online childhood obesity treatment and prevention programs have promising potential and that well-designed high-quality trials are needed to improve the evidence base, particularly trials which involve parents as the agent of change (Nguyen et al., 2011). To date, there are no known randomized controlled trials examining the effect of parent-focused online interventions on BMI in children of pre-school age, a gap in the research that this thesis addresses.

1.2 Aim and research questions

The research aim of this thesis was to investigate the efficacy of the *Time2bHealthy* online program in facilitating behavior change among preschool-aged children who are overweight, or at risk of becoming overweight. More specifically, the research questions were:

Primary research question:

1. What is the effect of the *Time2bHealthy* online lifestyle behavior change program on child BMI?

Sub research questions:

1.1 What is the effect of the *Time2bHealthy* online lifestyle behavior change program on child:

a) Dietary intake (energy intake, sugar intake, saturated fat intake, fruit and vegetable intake, discretionary food intake and sugar-sweetened beverage intake)
b) Physical activity
c) Screen-time
d) Sleep

1.2 What is the effect of the *Time2bHealthy* online lifestyle behavior change program on parental role-modelling and parent self-efficacy in the above behaviors?

1.3 What is the effect of the *Time2bHealthy* online lifestyle behavior change program on parent child feeding beliefs and practices?

1.4 Was the intervention effect on BMI change mediated by changes in obesity-related variables or moderated by baseline participant characteristics?

1.5 Did participants who highly engaged in the Facebook discussion group achieve superior outcomes to participants with a lower level of engagement?

1.3 Thesis outline

This thesis commences with a systematic review and meta-analysis of parent-focused eHealth childhood obesity interventions in Chapter 2, where gaps in the literature are identified, in particular the lack of high-quality interventions in the five and under age group, providing justification for this research. The findings of this systematic review and meta-analysis were used to guide the development of the *Time2bHealthy* intervention and the study design.

Chapter 3 outlines the methods used for this research, incorporating the study design, participant recruitment and eligibility criteria, intervention mapping process, theoretical framework, outcome measures and the statistical analysis method. The chapter also describes the strengths, risks and limitations of the study design.

Chapter 4 presents the main outcomes of the *Time2bHealthy* randomized controlled trial. The effect of *Time2bHeathy* on the primary outcome of child BMI and the secondary outcomes of child dietary intake, physical activity, screen-time and sleep and parent self-efficacy, parental modelling and child feeding are discussed. Process evaluation results are also presented.

Chapter 5 seeks to gain an understanding of the mechanisms of change. Mediation and moderation analyses were conducted to determine if change in child BMI at 6-months post-baseline was moderated by demographic characteristics or mediated by changes in obesity-related variables at 3-months post-baseline.

Chapter 6 explores the effect of the Facebook discussion group. Further analyses were conducted on primary and secondary outcome data to determine if participants who highly engaged in the Facebook group achieved superior outcomes to participants who had a lower level of engagement.

Finally, Chapter 7 summarizes the results of this thesis in relation to the research aims. Strengths and limitations of the research are discussed and recommendations for future directions of research in this area are provided.

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Chapter 2

Literature Review

This chapter will first define childhood obesity, then discuss the prevalence rates and health and other consequences of childhood obesity. The causes of childhood obesity will then be considered before exploring the effect of parental influence, parent self-efficacy and child feeding on childhood obesity. A general overview of parent-focused childhood obesity prevention and treatment interventions will then be briefly discussed. A systematic review and meta-analysis, which was published in the *Journal of Medical Internet Research* in 2016, will then be presented. This review summarizes the evidence for BMI/BMI *z*-score improvements in eHealth overweight and obesity randomized controlled trials (RCT) for children and adolescents, where parents or carers were the agent of change. Finally, relevant studies which were published since the publication of the systematic review and meta-analysis will be discussed.

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2.1 Overview

Childhood obesity has become a worldwide epidemic in the past few decades. Despite some evidence of plateauing in recent years in some countries, the rates remain incredibly high (Ng et al., 2014). Childhood obesity tracks from early childhood to adulthood and results in short-term and long-term health issues (Luttikhuis et al., 2009), meaning that prevention and early intervention is paramount (Ho et al., 2012; Luttikhuis et al., 2009). The World Health Organization (WHO) has recommended that multi-sectorial initiatives are applied to address the issue, including the implementation of interventions across a range of settings (World Health Organization, 2017). Furthermore, it has been recommended that childhood obesity interventions should actively involve parents (Barlow, 2007; Davis et al., 2007). Parent-focused interventions which have used an eHealth medium have the potential for broad reach and while research in this area is increasing, more studies are needed.

2.2 Background

2.2.1 Definition and measurement of childhood overweight and obesity

Overweight and obesity refer to the presence of excessive body fat to a degree that it can be detrimental to health (World Health Organization, 2000). The WHO define overweight for children aged 0-5 years as two standard deviations above, and obesity as three standard deviations above the WHO Child Growth Standards median. For children aged 5-18 years, the definition of overweight is one standard deviation above, and obesity is two standard deviations above the WHO Child Growth Standards median (World Health Organization, 2017). In children, body composition varies according to developmental growth stages; thus there are different child BMI / weight for height reference values available, but for the main intervention in this thesis, WHO reference values were used.

2.2.2 Prevalence of childhood obesity

Rates of childhood obesity have increased worldwide over the past 40 years and while escalation has slowed in some countries, albeit at a very high level, in other countries, rates continue to rise (Australian National Preventive Health Agency, 2014). Worldwide, 170 million children have overweight or obesity (World Health Organization, 2012). The rate of childhood overweight and obesity is 23% in developed countries (Ng et al., 2014), with the prevalence in Australia being similar, with 20% of children aged 2-4 years and 28% of children aged 5-17 years classified as overweight or obese (Australia Bureau of Statistics, 2015).

2.2.3 Health and other consequences of childhood obesity

There are a number of health consequences of overweight and obesity, both short- and long-term. Health problems include obstructive sleep apnea (Kohler et al., 2009) (Andersen, Holm, & Homøe, 2016; Narang & Mathew, 2012), liver disease (Papandreou, Rousso, & Mavromichalis, 2007), metabolic syndrome (Li, Ford, Zhao, & Mokdad, 2009; Weiss, Bremer, & Lustig, 2013), insulin resistance (Lobstein, Baur, & Uauy, 2004; Romualdo, Nobrega, & Escrivao, 2014), type 2 diabetes (Australian Institute of Health and Welfare, 2014; Lobstein et al., 2004; Pulgaron & Delamater, 2014), musculoskeletal disorders (Paulis, Silva, Koes & van Middelkoop, 2014; Smith, Sumar, & Dixon, 2014) and development of cardiovascular disease risk factors such as hypertension and dyslipidemia (Lobstein et al., 2004; Park, Falconer, Viner, & Kinra, 2012). Such conditions previously only prevalent in adults are now being seen increasingly in children. Also of concern is the risk of earlier onset of menstruation and polycystic ovarian syndrome in girls (Lobstein et al., 2004).

There are psychosocial consequences of childhood overweight and obesity, which often arise prior to physical health consequences. Children can be perceived poorly by their peers and may experience teasing, bullying, discrimination and resultant low self-esteem and depression (Buttitta, Iliescu, Rousseau & Guerrien, 2014; National Health and Medical Research Council of Australia, 2013b; Schwartz & Puhl, 2003). While the most common consequences of childhood obesity have been discussed above, it should be noted that this list is not exhaustive.

Childhood obesity tracks from childhood into adulthood, with obese children being around five times more likely to remain obese into their adult life compared to children in the healthy weight range (Simmonds, Llewellyn, Owen, & Woolacott, 2016) and children with obesity in childhood likely to be more obese than those who develop obesity in their adult years (Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001). The duration of childhood obesity is thought to have an effect on the risk of disease (Ortega, Lavie, & Blair, 2016; World Health Organization, 2000), with obesity-related health problems in adults likely to be more severe when obesity has been established in childhood rather than developing in adult years (Bass & Eneli, 2015).

Past studies in various countries have reported higher healthcare costs for children with obesity (Trasande & Elbel, 2012). A recent study estimated that the direct healthcare costs of childhood obesity in Australia for children aged 2-4 years is $17 million per year, equating to an extra $367 per year per child compared to children in the healthy weight range (Brown, Moodie, Baur, Wen, & Hayes, 2017). This is contrary to previous reports that costs of childhood obesity generally start to appear in school-aged children (Trasande & Elbel, 2012). Therefore, the potential cost benefits from investing in childhood obesity prevention in early childhood could be substantial (Brown et al., 2017).

2.2.4 Causes of childhood obesity

At the most basic level, childhood obesity results from an imbalance of food intake and physical activity. However, the underlying causes of this imbalance are multifactorial and complex and include environmental and individual factors. Davison and Birch (2001) proposed a model for predicting child weight status based on the Ecological Systems Theory. The model proposes that weight status is determined by child, family and community/demographic characteristics. Child personal characteristics and risk factors include age, gender, sedentary behavior, physical activity, dietary intake and genetic susceptibility for weight gain. These factors are influenced by the next level of factors; which are family/parenting characteristics, such as child feeding practices, and parent dietary and physical activity behaviors, which are influenced by demographic and community characteristics, such as socioeconomic status, culture and ethnicity, food and physical activity environment and factors influencing family life such as parent work demands (Davison & Birch, 2001). The key determinants across each level of the Ecological Systems Theory which are relevant to this doctoral research will be discussed below. Reference will be made to global, as well as Australian evidence and guidelines, however focus is placed upon the evidence and guidelines from Australia as the location for this doctoral research was in Australia.

2.2.4.1 Child Characteristics

2.2.4.1.1 Dietary intake

Internationally, dietary guidelines recognize the importance of a balanced dietary intake for overall health and prevention of unhealthy weight gain and chronic disease (Food and Agriculture Organization of the United Nations, 2018). The Australian Dietary Guidelines provide recommendations on the foods required for optimum health and wellbeing and outline the recommended serves per day of the core food groups for different age groups (National Health and Medical Research Council of Australia, 2013a).

A recent Australian survey found that less than 1% of Australian children achieve the recommended daily serves of vegetables per day. Compliance with fruit guidelines was better, but was lower in older children, starting with 78% in 2-3 year-old children, dropping to 59% for 4-8 year-olds, 39% for 9-13 year-olds and 27% for 14-18 year-olds (Australian Bureau of Statistics, 2016a). Compliance with dietary guidelines in other countries has also been reported to be poor (Kim et al., 2014; NHS Digital, 2018; Suggs, Della Bella, & Marques-Vidal, 2016). In recent decades, there has been an increase in energy intake in children in Australia and in other countries (Duffey & Popkin, 2013; National Health and Medical Research Council of Australia, 2013a). This is thought to be due to a number of factors. Notably, consumption of discretionary foods (which are energy dense and nutrient poor) is at staggeringly high levels in Australian children, with almost all exceeding the recommended maximum intake. Intake from these foods accounts for around 40% of Australian children's energy intake (Johnson, Bell, Zarnowiecki, Rangan, & Golley, 2017), with similar high rates also noted in other countries (Piernas & Popkin, 2010; Wang, van der Horst, Jacquier, Afeiche, & Eldridge, 2018). There is also a trend for fewer meals being prepared at home and increased consumption of convenience, takeaway and fast foods in many countries, including Australia (Xue, Wu, Wang, & Wang, 2016; Australian Bureau of Statistics, 2017; Poti & Popkin, 2011).

2.2.4.1.2 Physical Activity

Adequate physical activity provides many health benefits for children, including prevention of unhealthy weight gain (Okely et al., 2012). The WHO has recommended the development and update of national physical activity guidelines (World Health Organization, 2018). *Australian Physical Activity and Sedentary Behaviour Guidelines for Children 5-17 years* have been established (Australian Government Department of Health and Ageing, 2014) and 24-hour Movement Guidelines have been developed for children aged 0-5 years. The 24-hour Movement Guidelines recognize the important interrelationship between physical activity, sedentary behavior and sleep (Australian Government Department of Health and Ageing, 2017). Since the release of such Guidelines in Australia and Canada, other countries such as United Kingdom, South Africa and the WHO have also developed 24-hour Movement Guidelines. Many other countries have physical activity guidelines which outline specific recommendations for children (Department of Health, Physical Activity, Health Improvement and Protection, 2011; US Department of Health and Human Services, 2008) while in some countries, such as China, the need for guidelines has been identified (Xu & Gao, 2018).

In Australia, guidelines recommend that children aged 0-1 years participate in floor activity, which includes 30 minutes of tummy time per day. Children aged 1-2 years should participate in three hours of physical activity which includes some energetic play and children aged 3-5 should also engage in three hours of physical activity, but it is specified for this age group that the energetic play portion of this should be at least one hour (Australian Government Department of Health and Ageing, 2017). For children aged 5-17 years, it is recommended that they participate in 60 minutes of moderate- to vigorous-intensity physical activity each day and muscle and bone strengthening activities at least three times per week (Australian Government Department of Health and Ageing, 2014). A considerable proportion of Australian children are not meeting the Australian physical activity guidelines. Just over one third of children aged 2-5 years do not achieve the three-hour per day target of physical activity for this age group (Australian Institute of Health and Welfare, 2018). Activity declines as children get older, with around three-quarters of children aged 5-12 years and over 90% of adolescents not achieving the 60-minute moderate- to vigorous-intensity physical activity target (Australian Institute of Health and Welfare, 2018). Sub-optimal child physical activity rates have also been reported in many other countries (Katzmarzyk et al., 2016; Liu et al., 2016; NHS Digital, 2018; World Health Organization, 2018).

2.2.4.1.3 Sedentary behavior and screen-time

Sedentary behavior is defined as “any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture" (Tremblay et al., 2017). The most concerning sedentary behavior from a health perspective is that which is associated with use of screens (Biddle, Garcia Bengoechea, & Wiesner, 2017) (such as TV, computers, tablets and smartphones). Sedentary screen-related behaviors in children, particularly TV use has been associated with a higher risk of obesity, as well as other health and social issues and poorer academic performance (Biddle et al., 2017; Carson et al., 2015; Jochem, 2018; Okely et al., 2012). As well as the displaced physical activity, there also appears to be other relationships between TV viewing and obesity, such as increased consumption of food while watching TV, exposure to unhealthy food advertising on TV and displaced sleep (Jochem, 2018; Zhang, Wu, Zhou, Lu, & Mao, 2016).

While many countries have developed physical activity guidelines, few have included specific recommendations on sedentary behavior (Okely, Tremblay, Hammersley & Aubert, 2018). *Australian 24-hour Movement Guidelines for the Early Years* recommend that children aged 0-2 years not engage in any screen-time and children aged 2-5 years engage in no more than one hour of screen-time per day. It is recommended that children under five years of age not be restrained for longer than one hour at any one period and sitting for extended periods of time is discouraged for children of all ages (Australian Government Department of Health and Ageing, 2014, 2017). It has been reported that only one in four Australian children aged 2-4 years, and one in three older children achieve the recommendations for screen-time (Australian Bureau of Statistics, 2013) and children spend high proportions of their day at preschool and school in sedentary behavior (Hinkley et al., 2012; Ridgers et al., 2012; Ellis et al., 2017).

2.2.4.1.4 Sleep Duration

Evidence is emerging regarding the association between both short sleep duration and poor sleep quality and obesity in children (Fatima, Doi, & Mamun, 2016; Miller, Kruisbrink, Wallace & Cappuccio, 2018; Wu, Gong, Zou, Li & Zhang, 2017). This relationship has been proposed to be due to several factors. First, being awake for longer allows more time for food consumption and sedentary behaviors such as TV viewing and use of other electronic devices, which are known to influence the risk of obesity. Other proposed mechanisms include changes to hormones responsible for regulating hunger and satiety, inflammatory responses and factors such as alteration of mood, attention and motivation (Miller et al., 2018). Sleep guidelines for children exist only in some countries (Hirshkowitz et al., 2015; Tremblay et al., 2017). The following sleep guidelines have been developed for Australian 0-5 year old children, as part of the 24-hour Movement Guidelines: 14-17 hours for 0-3 month-olds, 12-16 hours for 4-11-month-olds, 11-14 hours for 1-2 year-olds and 10-13 hours for 3-5 year-olds (Australian Government Department of Health and Ageing, 2017). 24-hour Movement Guidelines are currently in the process of being developed in Australia for 5-17 year old children. Current Sleep Foundation guidelines in the USA recommend 9-11 hours for 6-13-year-olds and 8-10 hours for 14-17-year-olds (Hirshkowitz et al., 2015). In a recent study, it was found that almost 90% of a sample of Australian preschool children met the sleep guidelines (Cliff et al., 2017). A study in school-aged children found that sleep levels had fallen since 1985 to 2004, but by 2013 had begun to rise again. Although there was no assessment against sleep guidelines, it appears that the mean sleep times at each time-point were within the recommended range of the Sleep Foundation Guidelines. However, both of these studies relied on self- or parent-report (Dollman, Matricciani, Booth, & Blunden, 2017). A recent survey indicated concern around the effect of screen use on sleep, with nearly half of Australian children using electronic devices at bedtime and of those children, one in four had sleep issues (Rhodes, 2017).

Recent reviews have assessed the combined effects of all movement behaviors (sleep, physical activity and sedentary behavior) in children and found that there are cumulative health benefits (Kuzik et al., 2017; Saunders et al., 2016). Combined effects of desirable movement behaviors have been found to be associated with lower adiposity and better motor development and fitness in children aged 0-4 years (Kuzik et al., 2017), and lower adiposity and better cardiovascular health in older children and adolescents (Saunders et al., 2016). It is therefore important that childhood obesity initiatives focus on all movement behaviors.

2.2.4.2 Family Characteristics

2.2.4.2.1 Parental Influence and Role Modelling

Parents are key influences in the development of childhood obesity, particularly for children up to the age of 12 years, a stage where children are largely dependent on their parents (Ho et al 2012). At this age, parents make decisions about the types of foods offered, physical activity opportunities provided, restriction of screen/sedentary behaviors and establishment of sleep routines. The role of parents in shaping positive health behavior habits is therefore central to changing the course of childhood obesity (Gruber & Haldeman, 2009; Ventura & Birch, 2008; Weihrauch-Bluher et al., 2018).

Parental influence and role modelling play a key part in establishing healthy behaviors such as healthy eating, physical activity and limited screen-time in childhood (Davison & Birch, 2001; Garriguet, Colley, & Bushnik, 2017; Golley et al., 2011; Natale et al., 2014; Niemeier, Hektner & Enger, 2012; Yavuz, van Ijzendoorn, Mesman, & van der Veek, 2015). Active parents are more likely to have active children (Mattocks et al., 2008) and parent role modelling of physical activity and the provision of support to allow for children to participate in physical activity both appear to be important facilitators for children to be active (Hutchens & Lee, 2018). Parents also play an important role in establishing a healthy mealtime environment and encouraging healthy food choices and practices (Birch, Savage, & Ventura, 2007). Starting in early childhood, children pay close attention to what their parents eat and children mimic the eating behaviors of their parents (Ostbye et al., 2013). The eating behaviors that children are exposed to at this stage of life can establish long-term eating patterns and food preferences (Ostbye et al., 2013).

Parent role modelling of healthy eating behaviors has been found to be associated with healthy eating behaviors in their children. Conversely and unhealthy eating behaviors in parents has been found to be associated with unhealthy eating behaviors in their children (Yee, Lwin, & Ho, 2017). Parent TV viewing habits have been found to be significantly associated with child TV viewing habits (Salmon, Tremblay, Marshall, & Hume, 2011), with similar associations found for mobile screen media use (Paudel, Leavy, & Jancey, 2016). Parent role modelling of healthy screen-time behaviors has been reported to be poor, so parent role modelling of this behavior has proven to be particularly challenging (Minges et al., 2015).

2.2.4.2.2 Parent self-efficacy

Self-efficacy, defined as confidence in a person's ability to achieve and maintain a pre-determined behavior, is behavior specific (so self-efficacy may be low in regard to one specific behavior and high in regard to another) (Bandura, 1986). Self-efficacy determines if an individual will initiate and maintain a change in behavior (Bandura, 1986; Bohman, Ghaderi, & Rasmussen, 2013). Parent self-efficacy is regarded as important for instigating change in obesity-related behaviors in children, however to date there have been limited studies which have investigated the effect of parent self-efficacy in establishing healthy behaviors in young children (Bohman, Rasmussen, & Ghaderi, 2016). The few studies which have explored the relationships between parent self-efficacy and child health behaviors have found a positive relationship between high parental (or maternal) self-efficacy and fruit and vegetable intake (Campbell, Hesketh, Silverii, & Abbott, 2010; Koh et al., 2014; Rohde et al., 2018) and MVPA (Rohde et al., 2018) and an inverse relationship with consumption of unhealthy food (Bohman et al., 2016; Campbell et al., 2010; Jago, Sebire, Edwards, & Thompson, 2013; Rohde et al., 2018). It is therefore important that childhood obesity interventions aim to increase parent self-efficacy to facilitate change in child obesity-related behaviors.

2.2.4.2.3 Child feeding practices

It is widely documented that parents' child feeding practices, beliefs and attitudes have a significant and lasting effect on child eating behaviors. Child feeding is known to influence a child's food preferences (Birch, Marlin, & Rotter, 1984; Birch, Zimmerman, & Hind, 1980), consumption habits and their ability to self-regulate (Birch, McPhee, Shoba, Steinberg, & Krehbiel, 1987). There is also evidence that child weight status is influenced by child feeding (Birch & Fisher, 1998, 2000). Parental practices which overly pressure children to eat healthy foods have been shown to lead to a reduced preference for these foods, lower fruit and vegetable intake, impaired self-regulation and fussy eating behaviors (Birch et al., 1984; Galloway, Fiorito, Francis, & Birch, 2006). Restriction of discretionary (or 'junk') foods, which are high in energy, has the counter-productive effect of an increased desire for these foods. External restriction also impairs children's own internal satiety cues and can lead to over-eating and resultant overweight and obesity (Birch et al., 1980; Fisher & Birch, 1999a, 1999b). Healthy weight status, self-regulation and a wide variety of food preferences have been associated with responsive feeding practices whereby the parent chooses and provides the food and the child decides what to and how much to eat (Hurley, Cross, & Hughes, 2011). Hence, while guidance of healthy eating behaviors is essential, it is important that parents not overly restrict food or pressure children to eat, but rather, take a more balanced approach, allowing children to develop self-regulation and respond to their own internal hunger and satiety cues (Satter, 2007). Educating parents about responsive child feeding practices (and thereby reducing child feeding practices which overly restrict foods or pressure children to eat) may assist in preventing unhealthy weight gain in young children (Ledoux, Robinson, Baranowski, & O'Connor, 2018).

2.2.4.3 Community/Demographic Characteristics

2.2.4.3.1 Food and Physical Activity Environment

The food and activity environment, which has changed over a number of years, is now described as obesogenic (or obesity promoting) (Egger & Swinburn, 1997; Weihrauch-Bluher et al., 2018; World Health Organization, 2017). Changes have included increased accessibility and high-level marketing of highly processed foods which are high in kilojoules, saturated fat, salt and sugar and increased portion sizes, while fresh whole foods, during this same time, have become more unaffordable for many families (National Health and Medical Research Council of Australia, 2013a; Baraldi, Steele, Carella, & Monteiro, 2018)). Housing density is increasing (Giles-Corti et al., 2012) and there is less availability of green space (Lachowycz & Jones, 2011; World Health Organization, 2016). Travel times to work, schools, shops and parks are becoming longer, which typically means more sedentary travel time if distances are too great or the areas are not conducive to active transport (Zapata-Diomedi & Veerman, 2016). Parents are working longer hours (Courtemanche et al., 2017) and there is a perception that outdoor environments are less safe for children, which results in less physical activity and more sedentary screen-time (Côté-Lussier et al., 2015).

2.3 Childhood obesity interventions

Effective interventions can reduce the likelihood of childhood overweight and obesity continuing into adulthood. Interventions which utilize joint dietary, physical activity and behavioral strategies have been shown to be the most effective in preventing and treating existing childhood obesity (Ho et al., 2012; Luttikhuis et al., 2009; Waters et al., 2011).

While healthy lifestyle education is crucial, there are significant barriers for families in implementing changes, highlighting the need for programs that aim to facilitate and overcome barriers to lifestyle behavior change (Gruber & Haldeman, 2009). Effective broad-reach interventions that target children are required (Luttikhuis et al., 2009). It has been established that parents are the key influence in the development of obesity-related behaviors and the involvement of parents in childhood obesity interventions is therefore paramount (Ho et al., 2012; Luttikhuis et al., 2009). Studies which have involved parents have demonstrated superior outcomes to those involving only children or optional parent involvement (Golan & Crow, 2004; Golan, Fainaru, & Weizman, 1998; Niemeier et al., 2012). Parent involvement is thought to be more critical in interventions targeting younger children (Ho et al., 2012; Luttikhuis et al., 2009). However, there is a recognized dearth of such studies in preschool-aged children (Luttikhuis et al., 2009), arguably the most important age for parental involvement (Ho et al., 2012). A meta-analysis of parent-focused obesity prevention and treatment interventions in early childhood (0-6 years) found that of the interventions that were successful in the long-term, all were commenced at preschool age, demonstrating the positive impact of parent involvement at this stage (Yavuz et al., 2015). Past interventions have been conducted in a number of settings, including preschool, school, community, healthcare, and the home (Ho et al., 2012; Luttikhuis et al., 2009; Nguyen, Kornman, & Baur, 2011; Waters et al., 2011), but it appears that home-based or health care settings are the most effective in obesity prevention interventions for children 5 years and younger, which at least in part is perhaps due to the higher level of parental engagement in these settings compared to education settings (Ho et al., 2012; Luttikhuis et al., 2009; Waters et al., 2011).

It has been suggested that future studies should investigate eHealth modes of delivery in the 0-5 age group, as such interventions have shown promise in older age groups (Laws et al., 2014). The use of eHealth in childhood obesity interventions offers advantages over face-to-face programs in regard to convenience and accessibility. A large proportion of Australian households are connected to the Internet (86% in 2016-17), including those in regional, rural and remote areas (Australian Bureau of Statistics, 2018), potentially enabling widespread access to programs regardless of geographic location. Internet usage is also high (Office for National Statistics, 2018; Pew Research Center, 2018) or rising steadily (China Internet Network Information Center, 2017) in many other countries. Two systematic reviews on eHealth-based childhood obesity interventions have reported promising results in improvement of childhood obesity-related behaviors such as dietary intake and physical activity. These reviews, however, did not specifically focus on interventions where parents were the agents of change. Also, the included studies were conducted in primary- or high-school age groups (An, Hayman, Park, Dusaj, & Ayres, 2009; Nguyen et al., 2011). Therefore, there is a clear gap in eHealth interventions which target early childhood, a key age for the establishment of healthy behaviors and parental influence.

In summary, current levels of childhood overweight and obesity are alarmingly high in Australia and globally (Australia Bureau of Statistics, 2015; Ng et al., 2014). There are many negative consequences of childhood overweight and obesity and complications are beginning to emerge at an earlier age than previously (Andersen et al., 2016; Kohler et al., 2009; Li et al., 2009; Lobstein et al., 2004; Narang & Mathew, 2012; Paulis et al., 2014; Romualdo et al., 2014; Weiss et al., 2013). Early intervention and prevention are therefore key to reducing life-long obesity-related health and psychosocial issues as well as reducing the short- and long-term financial burden of childhood obesity (Brown et al., 2017; World Health Organization, 2017). There are many causes of childhood obesity, which are the result of a combination of: child characteristics (such as dietary intake, physical activity, screen-time and sleep), family/parent characteristics (such as parental influence and role modelling, parent self-efficacy, and child feeding practices) and community characteristics (such as the food and physical activity environment) (Davison & Birch, 2001; National Health and Medical Research Council of Australia, 2013b). Effective broad-reach childhood obesity treatment and prevention interventions that target obesity-related behaviors are needed (Luttikhuis et al., 2009; World Health Organization, 2017). Parental influence is key to establishing healthy behaviors (Ho et al., 2012) and parental involvement in childhood obesity interventions is therefore critical, particularly in early childhood, where parental influence is most dominant (Barlow, 2007; Davis et al., 2007; Luttikhuis et al., 2009; Yavuz et al., 2015). eHealth-based childhood obesity interventions have the potential for scalability and have shown promise in improving obesity-related behaviors, but to date, there have been no studies conducted in children under the age of 5 years and furthermore many eHealth studies have lacked parent involvement (An et al., 2009; Nguyen et al., 2011).

2.4 Published systematic review and meta-analysis

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2.4.1 Introduction

The escalating global challenge of childhood obesity has been well documented, with prevalence rates climbing to approximately 23% in developed countries and 13% in developing countries (Ng et al., 2014). Childhood is a period of time where unhealthy behaviors such as consumption of energy dense foods and beverages, physical inactivity and sedentary behavior are established (Yavuz et al., 2015). During this time parental influence and role-modelling play a key part in the development of such behaviors (Golley et al., 2011; Natale et al., 2014; Niemeier et al., 2012). Parental involvement in childhood obesity interventions appears to be important, given that children are highly influenced by the family unit (Gruber & Haldeman, 2009; Ventura & Birch, 2008). Recent systematic reviews and meta-analyses have investigated the effectiveness of parent-focused childhood obesity prevention and treatment interventions, with the weight of the evidence supporting the use of parent-focused interventions. A 2012 meta-analysis of weight-related behavior change interventions for 2-19 year olds where parents were involved resulted in greater body mass index (BMI) reductions than interventions that had optional or no parent involvement (Niemeier et al., 2012). These are similar findings to two meta-analyses of children aged 5-12 (Ewald, Kirby, Rees, & Robertson, 2014; Young, Northern, Lister, Drummond, & O'Brien, 2007), whereas another meta-analysis of 2-18 year olds found that interventions that targeted parents had a smaller (yet still significant) effect than those which targeted children directly (Peirson et al., 2015).

The lack of studies in preschool-aged children has been highlighted (Luttikhuis, Baur, Jansen, Shrewbury, et al., 2009). Of the aforementioned 2 meta-analyses that sought to include studies which involved children from 2 years of age, one included no studies in the preschool age group and the other included only 2 studies in this age group

(Niemeier et al., 2012; Peirson et al., 2015). A meta-analysis of parent-focused obesity prevention and treatment interventions in the early childhood (0-6 years) age-group demonstrated a small, yet significant combined effect in the short-term, but in the long-term, the combined results were not significant (Yavuz et al., 2015). When the studies were looked at individually, five were successful in the long-term, which were all commenced at preschool age. The baseline BMI of the children appeared to be a factor in this meta-analysis, as two of the three studies that were successful at both short- and long-term follow-up included only children who were overweight or obese (Yavuz et al., 2015).

Effective broad-reach interventions that target childhood are required; however currently there is little consensus on the most effective intervention approach (Luttikhuis et al., 2009). As mentioned, interventions which target parents are effective (Niemeier et al., 2012; Yavuz et al., 2015; Young et al., 2007). In addition, the use of eHealth interventions also hold promise in this area, with the use of such technology in the child and adolescent age groups having increased in recent years (Nguyen et al., 2011). Two previous reviews have investigated the impact of technology-based overweight and obesity interventions in childhood and adolescence with some studies reporting changes in adiposity, dietary and/or physical activity outcomes (An et al., 2009; Nguyen et al., 2011). However, neither of these previous reviews have specifically investigated the effect of parent involvement.

This current systematic review and meta-analysis builds on previous reviews, but differs in that it is, to the author’s knowledge, the first to measure the efficacy of eHealth interventions in improving BMI or BMI *z*-score in children and adolescents where parents are an agent of change. This review is of importance in determining effective broad-reach approaches to prevent and treat childhood obesity, which in the long term could potentially alter the path of childhood obesity and reduce the progression into adult life. The review adopts a broader definition of eHealth than one of the previous reviews and includes interventions using the internet, IVR (Interactive Voice Response: computerized voice prompts over the telephone, which participants respond to via the telephone keypad), social media (Facebook, Twitter and so forth), mobile health (such as mobile phone apps), telemedicine (utilizing video conferencing), email and e-learning. The objective of this current systematic review and meta-analysis was to determine whether eHealth childhood and adolescent overweight and obesity interventions, where parents/carers are the agents of change, improved BMI and/or BMI *z*-scores.

2.4.2 Methods

The protocol for this systematic review and meta-analysis was registered in advance with the PROSPERO international prospective register of systematic reviews (registration number CRD42015019837) and conforms with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, & Altman, 2009).

2.4.2.1 Eligibility criteria

2.4.2.1.1 Type of studies

Randomized controlled trials investigating the effect of eHealth interventions on weight of children and adolescents, where parents or carers were an agent of change, were considered for this systematic review and meta-analysis. Studies were excluded if participants had special needs or had a condition where physical activity was restricted or if they required a special diet. Studies not published in English were also excluded.

2.4.2.1.2 Type of participants

eHealth studies targeting obesity prevention or treatment for children and adolescents aged 0-18 years, where parents/carers were agents of change were considered. The parent or carer being an agent of change was defined as the parent or carer having an active role in the intervention and being responsible for implementing change.

2.4.2.1.3 Types of interventions

Interventions investigating the effect of eHealth on BMI were considered for inclusion. No restrictions were placed on the type of setting, provided that the parent or carer was an agent of change.

2.4.2.1.4 Types of outcome measures

Primary outcome measures were BMI and/or BMI *z*-score at baseline and post-intervention. Secondary outcomes included body fat, waist-hip ratio and improvements to dietary intake, physical activity, sedentary behavior, screen-time, biomedical indicators (such as blood pressure and cholesterol), knowledge and self-efficacy.

2.4.2.2 Search strategy

The electronic databases of A+ Education, Cinahl, Proquest Central, PsycINFO, Scopus, SPORTDiscus and Web of Science were searched with a limitation date of January 1995-April 2015 using pre-determined search terms (see below).

1. child* OR adolescen* OR paediatric OR pediatric OR teen OR youth

2. famil* OR parent* OR Carer*

3. e-health OR eHealth OR internet OR technology OR web* OR online OR mhealth OR m-health OR mobile OR "social media" OR "social network*" OR email OR telemedicine OR e-learning OR elearning

4. *weight OR obes*OR BMI OR adipos* OR nutrition OR diet* OR activ* OR lifestyle OR "behaviour change" OR "behavior change" OR promot* OR "health behaviour" OR "health behavior"

5. RCT OR interven* OR program* OR manag* OR prevent* OR trial*

Pre-1995 articles were not included as it was thought that any interventions at this early stage would be exceedingly basic. In addition, the reference lists of relevant articles were scanned.

2.4.2.3 Study selection

Following the database searches, one author (MH) removed duplicates and screened the titles of the articles, and relevant articles were short-listed. A second author (RJ) then checked the decisions made. The abstracts of the remaining articles were then screened (by MH) and a second shortlist was derived and checked by a second author (RJ). The full text of the remaining articles was retrieved and read by author one to create a final shortlist. The shortlisted articles were then viewed by the second author (RJ). Any differences were discussed and a decision was made by consensus. Where a decision was not able to be reached, a third author (AO) reviewed the papers to make a final decision.

2.4.2.4 Data collection process

One review author (MH) independently extracted the data from the included studies. Contact was made via email with the author of one paper to request additional data on BMI at a time-point during the study, which was utilized in the meta-analysis and systematic review.

2.4.2.5 Risk of bias in individual studies

Two reviewers (AO and MH) independently assessed risk of bias using a checklist adapted from the Consolidated Standards of Reporting Trials statement (see **Table 2.1**) (Schulz, Altman, & Moher, 2010). In line with the recommendations of the PRISMA statement, each of the items on the checklist was evaluated separately rather than an overall score being assigned. Each item was given a + or – according to whether the item was described adequately in the article (+) or not adequately described or not present (-). Any differences were discussed, and a decision was made by consensus.

Table 2.1: Risk of bias checklist

Item	Description
A	Key baseline characteristics are presented separately for treatment groups (age, gender and body mass index - BMI)
B	Randomization procedure clearly and explicitly described and adequately carried out (generation of allocation sequence, allocation of concealment and implementation)
C	Valid measurement of BMI (at minimum, standardized method used to measure height and weight and to calculate BMI are described)
D	Drop out described and ≤20% for <6-month follow-up or ≤30% for ≥6-month follow-up

Item	Description
E	Blinded outcome assessment (positive when those responsible for assessing BMI were blinded to the group allocation of individual participants)
F	Intention-to-treat analysis for BMI outcome(s) (participants analyzed in group they were originally allocated to and participants were not excluded from analyses because of non-compliance to treatment or because of missing data)
G	Covariates accounted for in analyses (e.g. baseline score, group or cluster, and other covariates when appropriate for age or gender)
H	Summary results for each group and adjusted scores presented (adjusted difference between groups and CI)
I	Power calculation reported, and the study was adequately powered to detect hypothesized relationships

2.4.2.6 Synthesis of results

Extracted data were first described in a narrative manner. Studies which reported BMI or BMI *z*-score results as change scores or baseline and final values; standard deviation (SD), standard error (SE) or confidence intervals (CIs); and the number of participants were included in a meta-analysis. Mean change was calculated where required, and SDs were calculated from SE or CI where SD was not reported (Higgins, 2011). Where the final SD value was missing, this value was imputed from baseline SD (Higgins, 2011). Missing SD change values were calculated using an imputed correlation coefficient (Higgins, 2011).

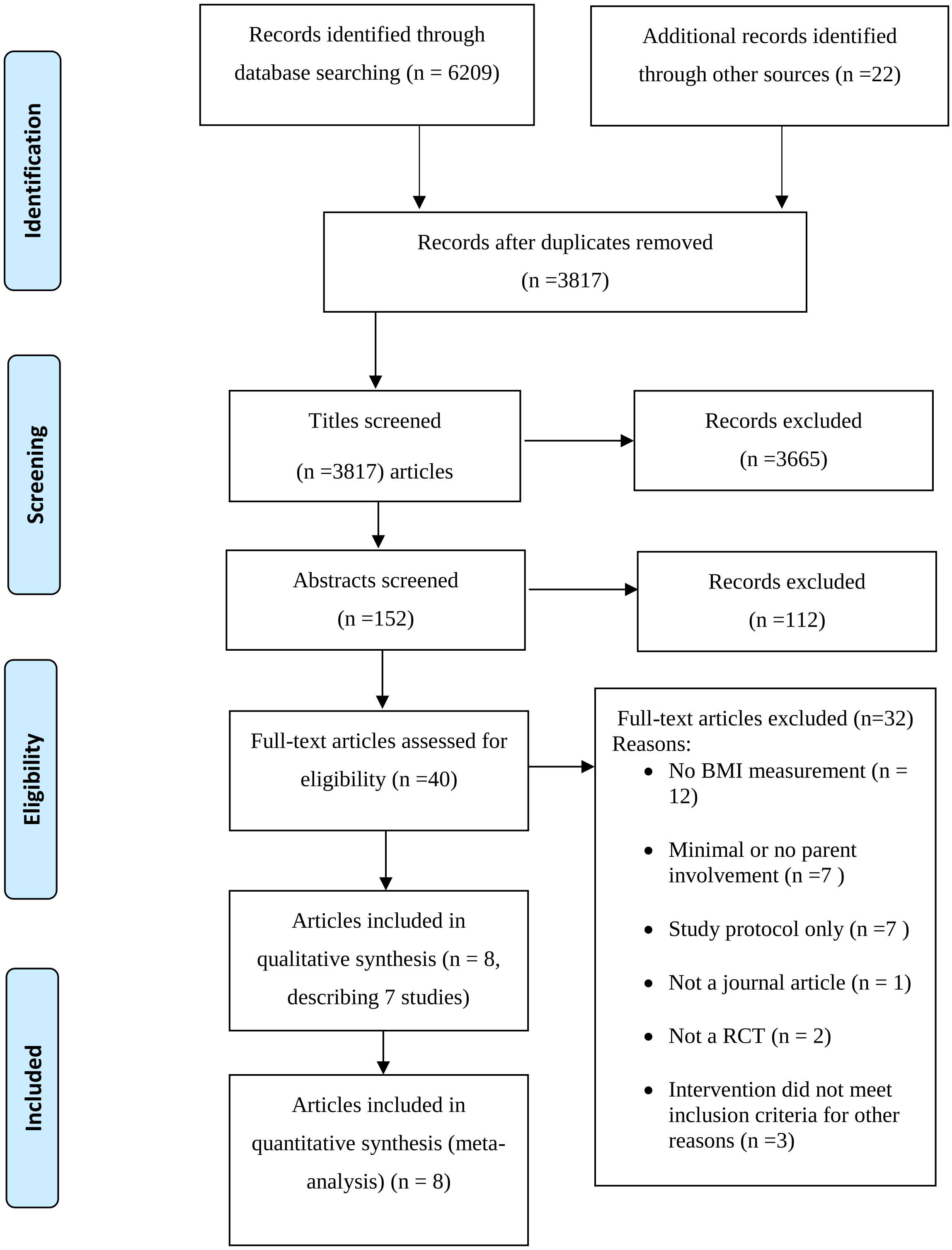
Where a study had two eHealth intervention arms, the number of participants in the control group was divided by two to ensure that participants were not counted more than once in the analysis. Heterogeneity was assessed via I2 index test. The meta-analysis was conducted with reported or calculated change scores for the data collection point closest to the end of the intervention. One study was reported across two articles (Williamson et al., 2005; Williamson et al., 2006) and the time-points in both of these articles were used (baseline to 6-months and 6-months to two years – which was calculated from the available data). To enable either BMI or BMI *z*-score to be included in the same meta-analysis, standardized mean difference (SMS) was used. Where a study reported both BMI and BMI *z*-score, BMI was used. One study involved a day camp before the implementation of the eHealth intervention, and therefore, the post-camp BMI measures were used as baseline measures for the purpose of the meta-analysis to isolate this component (Baranowski et al., 2003). A random effects model was applied to the analysis given the heterogeneity across the studies (Higgins, 2011). Analysis was conducted utilizing Review Manager (RevMan) [Computer program]. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

2.4.3 Results

2.4.3.1 Study selection

From the 3817 papers that were initially identified, eight papers describing seven separate studies met the inclusion criteria (**Figure 2.1**).

Figure 2.1: Study selection flow diagram



2.4.3.2 Description of studies

Table 2.2 outlines the characteristics of the studies meeting the inclusion criteria; seven studies were conducted in the past 10 years, and only one study was conducted outside the United States (in France) (Paineau et al., 2008). There were a total 1487 dyads participating in the included eight studies (range 35 to 1013 dyads). A range of cultural or ethnic groups participated in studies, including African American (with three studies including only African American participants (Baranowski et al., 2003; Williamson et al., 2005; Williamson et al., 2006)), Latino (Estabrooks et al., 2009), Chinese-American (one study included only Chinese-American participants (Chen, Weiss, Heyman, Cooper, & Lustig, 2011)) and French (Paineau et al., 2008). Five studies were overweight or obesity treatment interventions (Davis, Sampilo, Gallagher, Landrum, & Malone, 2013; Estabrooks et al., 2009; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013) and three studies overweight prevention interventions (Baranowski et al., 2003; Chen et al., 2011; Paineau et al., 2008). The gender proportions of the child or adolescent participants were 47.21% male and 52.79% female. Two of the studies included girls only (Williamson et al., 2005; Williamson et al., 2006). Parent gender was reported in only one study (Wright et al., 2013), where 96% were female. In total, three studies involved children (range 7-10 years) (Baranowski et al., 2003; Davis et al., 2013; Paineau et al., 2008), three studies involved adolescents (range 11-15 years) (Chen et al., 2011; Williamson et al., 2005; Williamson et al., 2006) and two studies included both children and adolescents (range 5-12 years) (Estabrooks et al., 2009; Wright et al., 2013). The length of the interventions ranged from 8 weeks to 2 years, with four studies being ≤12 weeks (Baranowski et al., 2003; Chen et al., 2011;

Estabrooks et al., 2009; Wright et al., 2013), three ≤8 months (Davis et al., 2013; Paineau et al., 2008; Williamson et al., 2005) and one study being 2 years in duration (Williamson et al., 2006). Only one study collected follow-up data to assess maintenance of changes in the months following the completion of the intervention (Chen et al., 2011). Retention rates were reported in seven studies and the average retention rate was 80% ± 6.3 (ranging from 70% to 93%) (Chen et al., 2011; Davis et al., 2013; Estabrooks et al., 2009; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013).

2.4.3.3 Description of interventions

Two of the studies had three study arms (Estabrooks et al., 2005; Paineau et al., 2008), and the remaining six studies had two study arms. Five studies utilized an Internet intervention (Baranowski et al., 2003; Chen et al., 2011; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006), two used IVR (Estabrooks et al., 2009; Wright et al., 2013) and one used telemedicine (Davis et al., 2013). Of the Internet interventions, one used Internet only (Chen et al., 2011), and others used the Internet in combination with face-to-face counselling (Williamson et al., 2005; Williamson et al., 2006), telephone counselling and nutrition lessons (Paineau et al., 2008) or a camp (Baranowski et al., 2003). The focus of behavior change differed between studies, with one focusing on diet, physical activity and screen-time (Estabrooks et al., 2009); six focusing on diet and physical activity (Baranowski et al., 2003; Chen et al., 2011; Davis et al., 2013; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006) and one focusing on diet and screen-time (Wright et al., 2013).

A theoretical framework underpinned four of the studies, two were underpinned by Social Cognitive Theory (Baranowski et al., 2003; Wright et al., 2013), one reported using a combination of Trans-Theoretical Model and Social Cognitive Theory (Chen et al., 2011) and one reported using Social-Ecological Theory (Estabrooks et al., 2009). Studies varied in the level of detail that they provided regarding how the theory was utilized in the design of the intervention.

The level of parental involvement varied among studies. In one study, only the parents participated in the intervention (children were involved only at the data collection stages) (Estabrooks et al., 2009). In the remaining seven studies, the parent and the child or adolescent both had active involvement in the intervention, either the child or adolescent participated in the eHealth activities with the parent together or there were separate components designed specifically for the parent and the child or adolescent (Baranowski et al., 2003; Chen et al., 2011; Davis et al., 2013; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013).

Studies used differing measures of adiposity, with most using multiple measures. Six studies used BMI (Baranowski et al., 2003; Chen et al., 2011; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013), four studies used BMI *z*-score (Davis et al., 2013; Estabrooks et al., 2009; Paineau et al., 2008; Wright et al., 2013), four studies used BMI percentile (Davis et al., 2013; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013), three used body fat (measured by DEXA (Baranowski et al., 2003; Williamson et al., 2005; Williamson et al., 2006) and one study used waist-to-hip ratio (Chen et al., 2011). Other measures included dietary intake (measured by food frequency questionnaire (Estabrooks et al., 2009; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013), 24-hour recall (Baranowski et al., 2003; Davis et al., 2013; Williamson et al., 2005; Williamson et al., 2006) or food records (Chen et al., 2011; Paineau et al., 2008)) physical activity (measured by questionnaire (Baranowski et al., 2003; Estabrooks et al., 2009; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006) or accelerometer (Baranowski et al., 2003; Chen et al., 2011; Davis et al., 2013)) and screen-time (measured by questionnaire (Estabrooks et al., 2009; Wright et al., 2013)).

Three of the studies reported on the effect of higher usage of the interventions. One IVR study reported that participants who completed more calls significantly decreased their BMI *z*-score compared with the control group (Estabrooks et al., 2009), while another IVR study reported that participants who were high IVR users demonstrated a significant reduction in BMI and BMI *z*-score compared with low IVR users (Wright et al., 2013). One of the internet studies, Williamson et al (2005) reported that change in percentage body fat was negatively correlated with use of an email facility to counsellors, performance on quizzes and use of an internet weight monitoring function.

Table 2.2: Summary of parent-focused childhood/adolescent obesity eHealth interventions

Author, Year, Country	**Participants**	**Intervention Description**	**Parental Involvement**	**Behaviors Targeted**	**Variables Measured**	**Key Findings**
Baranowski et al 2003, USA	n=35, 8 years of age, girls	4-wk camp with specially designed activities, followed by 8-wk behavior change internet intervention. Control girls attended camp with usual activities and a monthly internet program with general health information and homework.	No parent involvement in camp. Intervention and control parents had access to a website which covered similar topics to girls' website.	Diet (dietary fat intake, dietary fiber, water and satiety, SSB), moderate to vigorous PA	Demographics, BMI, WC, physical maturation, body fat (DEXA), diet (2 x 24-hr recall), PA (accelerometer and qne), preferences for PA and SSB.	For the internet component, no significant changes to BMI were observed. No other variables were measured at the end of the camp, so the effect of the internet intervention on variables other than BMI could not be determined.
Chen et al 2011, USA	n=54, 12-15 years of age Chinese-American	Behavior change internet program with goal setting tailored to stage of change. 8 x weekly sessions for children. Control	Parents received 3 internet sessions over 8 wks to increase	Diet (food pyramid, meal planning, portion	Parent height and weight, child BMI, waist-to-hip ratio, blood pressure, PA (accelerometer), diet (3-day food diary), PA	Significantly more participants in the intervention group reduced their waist-to-hip ratio than the control group (effect size= -0.01, *P*=0.02). There

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		participants accessed a general health information internet site.	knowledge and skills.	size), PA	and nutrition knowledge (qne), dietary and PA self-efficacy.	were also significant increases in PA (effect size=12.46, *P*=0.01), increases to F&V intake (effect size=0.14, *P*=0.001) and increased PA knowledge (effect size=0.16, *P*=0.008) and nutrition knowledge (effect size=0.18, *P*=0.001).
Davis et al 2013, USA	n=58, 5-11 years of age, rural setting	8 x weekly telemedicine delivered psychoeducational sessions covering goal setting, diet and PA, plus 6 x monthly sessions. Control participants visited their primary care physician to discuss	Parents met in a group separately, but as the same time as the children and covered similar content.	Nutrition (stop-light diet, portion sizes, food labels, vitamins and minerals, nutrient density),	Demographics, BMI *z*-score, diet (24-hr recall), PA (accelerometer), child behavior checklist, behavioral pediatrics feeding assessment scale.	No statistical difference in BMI *z*-score between groups. There was also no significant difference between groups for kilocalories or PA.

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		set topics.		energy balance, PA, screen-time and SB[e].		
Estabrooks et al 2009, USA	n=220, 8-12 years of age	Group A: 2 x 2hr weekly group sessions on nutrition, physical activity, problem solving and action planning delivered by dietitian. Group B: attended group sessions plus ten IVR follow-up sessions, involving goal setting at end of call. Both groups received a workbook with	Parent was main agent of change (children participated in data collection only)	Weight, nutrition, PA, parenting skills.	BMI *z*-score, PA and SB (questionnaire) F&V and SSB consumption (qne), eating disorder symptoms (qne).	No significant difference in BMI *z*-score between groups. Significant increase in Moderate-intensity PA in IVR group but no difference b/w groups. Participants completing 6-10 IVR calls significantly reduced BMI *z*-score compared to other groups ($F[3,148]=-2.89$, $p<0.01$).

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		homework on nutrition and physical activity topics. Control group received workbook only.				
Paineau et al 2008, France	n=1013, 7-9 years of age	All intervention families accessed a website containing information, interactive components, and other functionality. They received 30-min dietary counselling telephone calls from a dietitian monthly for 8 months after web-based completion of	Families accessed website and received phone calls. Parents received monthly newsletter.	Nutrition (portions, frequency of eating, meal modification and healthier alternatives)	Demographics, BMI, BMI *z*-score, body fat, WC, chest circumference, knee circumference, dietary intake (total energy, fats, sugars, complex CHO, protein) (web-based qne and dietary records), PA (qne)	No significant difference between groups in regard to BMI or other anthropometric measures. Group A: Significantly increased complex CHO intake (mean change +10.1 (6.0 to 14.2) 95% CI, p<0.05). Group B: Significantly reduced sugar intake (mean change -10.0 (-13.4 to -6.6) 95% CI, p<0.01). Both group A & B reduced total energy (mean

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		questionnaires. Children received 3 nutrition lessons at school. Children and parents received monthly newsletters. Group A: advised to reduce fat and increase complex CHO, Group B: advised to reduce fat and sugars and increase complex CHO. Control group received only general nutrition information at the same intervals.				change A -60 (-104 to -15) 95% CI, p<0.05, B -96 (-146 to -45) 95% CI, p<0.01) and fat intake (mean change A -8.2 (-10.6 to -5.8) 95% CI, p<0.01, B -8.3 (-10.8 to -5.7), 95% CI, p<0.01) compared to control group. No difference in PA between groups.
	n=57, 11-15 years of age,	Behavioral website providing nutrition	Parent and adolescent	Nutrition (low energy	Demographics, BMI, BMI percentile, body	Participants in the intervention group lost

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
Williamson et al 2005, USA	African-American girls	information and behavior modification for 6-months. Counselling provided via email. Control group had access to general non-interactive health website. 4 face-to-face sessions over12 wks, focused on goal setting, behavioral contracting, monitoring of progress and problem-solving. Control group sessions were general nutrition information conducted by a dietitian and included general	participated in the face-to-face and internet components together	diet, F&V, PA, food monitoring)	fat (DEXA), eating disorders, pubertal status, dietary intake (24-hr recall and FFQ), weight loss behavior scale, child dietary self-efficacy scale, PA social support, children's eating attitudes test, satisfaction with life scale, child depression inventory, Rosenberg self-esteem scale, Kansas family life satisfaction scale, symptom checklist-90	significantly more body fat than the control group (-1.12 +/- 0.47 SE, $p<0.05$). There was a significant difference in BMI change between groups (intervention -0.19 +/- 0.24 SE, <0.05, control +0.65 +/- 0.23 SE, $p<0.05$). Participants in the intervention group significantly reduced fat intake compared to control group (FFQ) (-145.67 +/- 37.67 SE, $p<0.05$),

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		information.				
Williamson et al 2006, USA	n=57, 11-15 years of age, African-American girls	Behavioral website providing nutrition information and behavior modification over 2 years. Counselling provided via email. Control group had access to general non-interactive health website. 4 face-to-face sessions over12 wks, focused on goal setting, behavioral contracting, monitoring of progress and problem-solving. Control	Parent and adolescent participated in the face-to-face and internet components together	Nutrition (low energy diet, F&V, PA, food monitoring)	Demographics, BMI, BMI percentile, body fat (DEXA), eating disorders, pubertal status, weight loss behavior scale, web site use, computer opinion survey.	At two years, there was no significant difference in BMI, weight or body fat. Higher BMI percentile at baseline was associated with greater reduction in BMI percentile. Higher weight loss behavior scale score at baseline was associated with greater improvement. In regard to reported consumption of fattening foods, there was a significant difference between groups (F (1,48) =2.08, p<0.05).

Author, Year, Country	**Participants**	**Intervention Description**	**Parental Involvement**	**Behaviors Targeted**	**Variables Measured**	**Key Findings**
		group sessions were general nutrition information conducted by a dietitian and included general nutrition information.				
Wright et al 2013, USA	n=50, 9-12 years of age	Parents and children individually received 12 x weekly IVR telephone counselling calls which provided education, monitoring and counselling on managing weight and reducing screen-time. Information sent via electronic health record to the child's pediatrician and used at visit one month after the intervention.	Received IVR calls independently to children.	Nutrition (energy, spotlight diet, healthy alternatives, cooking and shopping, eating out), screen-time	BMI, dietary intake (energy, fat, fruits, vegetables) (questionnaire), TV viewing time (questionnaire)	There was no significant difference between groups for BMI, BMI *z*-score, dietary intake or screen-time. There was a significant difference in weight (-4.0 change, *P*=0.001), BMI (-1.2 change, *P*=0.01) and BMI *z*-score (-0.1 change, *P*=0.04) between high users and low users.

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		Control participants attended the same pediatrician visit.				

PA= physical activity, F&V=fruit and vegetables, SB = sedentary behavior, WC=waist circumference, SSB=sugar-sweetened beverages, CHO=carbohydrate, qne=questionnaire, IVR=interactive voice response.

2.4.3.4 Risk of bias within studies

Table 2.3 summarizes the results of the risk of bias assessment for all included studies. Of the eight studies, six reported key baseline characteristics separately for each study arm. Seven studies reported an acceptable drop-out rate (≤20% for <6-month follow-up or ≤30% for ≥6-month follow-up), and the remaining study did not report drop-out rates. Six studies used intention-to-treat analysis for BMI outcomes, seven studies accounted for covariates in the analysis, and power calculations were reported and adequate in five articles. Only two studies described an adequate randomization procedure and/or reported summary results for each group with adjusted scores, and none of the studies described a valid, standardized method of BMI measurement.

Table 2.3: Risk of bias assessment in randomized controlled trials assessing BMI outcomes of parent-focused eHealth overweight and obesity interventions

Study	**Baranowski et al 2003**	**Chen et al 2011**	**Davis et al 2013**	**Estabrooks et al 2009**	**Paineau et al 2008**	**Williamson et al 2005**	**Williamson et al 2006**	**Wright et al 2013**
Baseline characteristics by group	+	-	+	+	+	+	-	+
Randomization described and conducted	+	-	-	-	-	-	-	+
Valid measurement of BMI	-	-	-	-	-	-	-	-
Drop out ≤20% for <6-months and ≤30% for ≥6-months	-	+	+	+	+	+	+	+
Blinded outcome assessment	-	-	-	-	+	-	-	-
Intention-to-treat for BMI outcomes	+	-	-	+	+	+	+	+
Covariates accounted for in analysis	+	-	+	+	+	+	+	+
Summary results + adjusted difference between groups + CI	+	+	-	-	-	-	-	-
Power calculation reported and power adequate	-	+	+	+	+	-	+	-

+ Adequately described and present, - absent. BMI – Body Mass Index; CI – Confidence Interval.

2.4.3.5 Results of individual studies

2.4.3.5.1 Adiposity outcomes

None of the included studies reported a significant difference between groups for BMI, BMI *z*-score, BMI percentile or percentage body fat from baseline to the end of the eHealth intervention. One study reported a significant difference in percentage body fat between groups at 6-months (-1.12 ± 0.47 SE, $p<0.05$) (Williamson et al., 2005); this change was not maintained at the end of the two-year intervention (Williamson et al., 2006). One study reported a significant difference between groups for waist-to-hip ratio from baseline to the end of the intervention (effect size = -0.01, $p = 0.02$), but reported no significant difference for BMI between groups (Chen et al., 2011).

2.4.3.5.2 Dietary outcomes

Four studies of the seven studies that assessed dietary intake (which were all Internet interventions) demonstrated a significant difference between groups in regard to improvement in at least one dietary outcome, such as fruit and vegetable intake (Chen et al., 2011), nutrition knowledge (Chen et al., 2011), total energy intake (Paineau et al., 2008), fat intake (Paineau et al., 2008; Williamson et al., 2005) and ‘eating less fattening foods’(Williamson et al., 2006).

2.4.3.5.3 Physical activity outcomes

Of the six studies that assessed physical activity, one study (which was an Internet intervention) demonstrated a significant difference between groups in objectively measured physical activity and physical activity knowledge (Chen et al., 2011).

2.4.3.5.4 Screen-time outcomes

Neither of the two studies that assessed screen-time demonstrated a significant difference between groups for screen-time (Paineau et al., 2008; Wright et al., 2013).

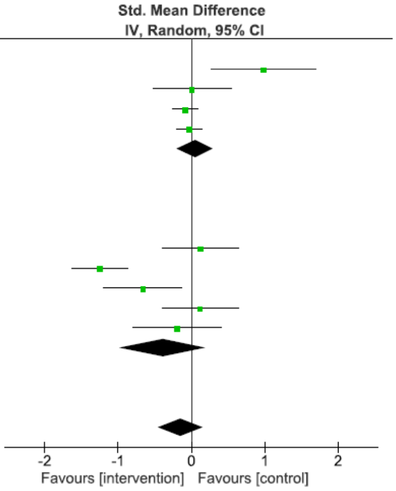
2.4.3.6 Synthesis of results

A meta-analysis was conducted on pooled data from eight papers with a total of 9 study arms, which compared eHealth intervention groups with control groups. The meta-analysis results are displayed in **Figure 2.2**. The studies were found to be significantly heterogeneous (I2=84%, 95% CI 71 to 91%, p<0.00001). There was no significant difference in the effects of the eHealth interventions compared to the control groups on BMI/BMI *z*-score (SMD -0.15, 95% CI -0.45 to 0.16, Z=0.93, *P*=0.35). A sensitivity analysis was conducted by removing an outlying study (Baranowski et al., 2003), with heterogeneity decreasing slightly (I2=83%, 95% CI 67 to 91%, p<0.00001) and although the standardized mean difference moved towards favoring the intervention (-0.25, 95% CI -0.55 to 0.05), significance was not reached (Z=1.63, *P*=0.10).

A sub-group analysis was conducted based on whether the study aim was obesity treatment or obesity prevention (refer to **Figure 2.2**). There was a larger effect for the obesity treatment studies (-0.39, 95% CI -0.97 to 0.20) compared to the obesity prevention studies (0.05, 95% CI -0.19 to 0.30), although this was not statistically significant. The obesity treatment studies appeared to have a higher level of heterogeneity (85%) than the obesity prevention studies (63%), however given the small number of studies included, this should be interpreted with caution.

Figure 2.2: Effect of eHealth interventions on BMI/BMI *z*-score

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
1.1.1 Obesity Prevention								
Baranowski 2003	2.628	3.247	19	-2.736	7.058	16	8.3%	0.98 [0.27, 1.69]
Chen 2011	-0.03	1.316	27	-0.04	1.347	27	10.3%	0.01 [-0.53, 0.54]
Paineau A vs Control 2008	0.05	0.967	297	0.13	0.939	209	14.2%	-0.08 [-0.26, 0.09]
Paineau B vs Control 2008	0.1	1.145	298	0.13	0.939	209	14.2%	-0.03 [-0.20, 0.15]
Subtotal (95% CI)			**641**			**461**	**47.1%**	**0.05 [-0.19, 0.30]**
Heterogeneity: Tau² = 0.03; Chi² = 8.22, df = 3 (P = 0.04); I² = 63%								
Test for overall effect: Z = 0.43 (P = 0.67)								
1.1.2 Obesity Treatment								
Davis 2013	-0.12	0.221	31	-0.15	0.26	27	10.5%	0.12 [-0.39, 0.64]
Estabrooks 2009	-0.07	0.017	85	-0.05	0.014	50	12.1%	-1.25 [-1.63, -0.87]
Williamson 2005	-0.19	1.27	28	0.65	1.239	29	10.3%	-0.66 [-1.19, -0.13]
Williamson 2006	0.92	3.233	28	0.55	2.889	29	10.5%	0.12 [-0.40, 0.64]
Wright 2013	-0.01	1.1	21	0.2	1	22	9.5%	-0.20 [-0.80, 0.40]
Subtotal (95% CI)			**193**			**157**	**52.9%**	**-0.39 [-0.97, 0.20]**
Heterogeneity: Tau² = 0.38; Chi² = 27.14, df = 4 (P < 0.0001); I² = 85%								
Test for overall effect: Z = 1.30 (P = 0.19)								
Total (95% CI)			**834**			**618**	**100.0%**	**-0.15 [-0.45, 0.16]**
Heterogeneity: Tau² = 0.17; Chi² = 49.96, df = 8 (P < 0.00001); I² = 84%								
Test for overall effect: Z = 0.93 (P = 0.35)								
Test for subgroup differences: Chi² = 1.86, df = 1 (P = 0.17), I² = 46.1%								



2.4.4 Discussion

This meta-analysis and systematic review is, to the author's knowledge, the first to measure the effects of parent-focused eHealth childhood obesity interventions on BMI / BMI *z*-score. Overall, it was determined by meta-analysis that the included interventions did not result in significant improvements to BMI or BMI *z*-score compared with a control group. However, four of the eight studies reported a significant improvement in at least one dietary or physical activity outcome measure.

The short duration of most studies may have meant there was insufficient time to detect changes in BMI or BMI *z*-score. The longest intervention demonstrated a significant improvement in body fat at the 6-month point (Williamson et al., 2005) but this was not sustained at the end of the intervention at 2 years (Williamson et al., 2006). Maintenance of weight loss in the long-term is indeed important but is a widespread challenge that has been well-documented in both adult and child/adolescent age groups

(Jones, Wells, Okely, Lockyer, & Walton, 2011; Luttikhuis et al., 2009). Previous parent-focused childhood or adolescent obesity systematic reviews and meta-analyses (which have not focused on eHealth) have highlighted the low proportion of studies which have a follow-up period of > 12 months (Golley et al., 2011; Niemeier et al., 2012; Yavuz et al., 2015) and one meta-analysis stated that there was a potential publication bias, meaning that some long-term follow-up studies with null results were not published (Yavuz et al., 2015). Likewise, the lack of long-term follow-up studies has also been identified in childhood or adolescent obesity eHealth systematic reviews (which have not concentrated solely on parent-focused interventions) and it has been recommended that future interventions incorporate long-term follow-up in their design (An et al., 2009; Nguyen et al., 2011).

Maintaining engagement in eHealth interventions can be challenging (Glasgow, 2007). The drop-out rates in the current meta-analysis ranged from 12-29%. Previous childhood obesity eHealth systematic reviews have reported drop-out rates up to 58% (An et al., 2009; Nguyen et al., 2011). For participants who complete an eHealth intervention, the level of engagement as measured by usage rates can vary. Two of the studies in this review reported that higher usage rates resulted in more favorable BMI or BMI *z*-score outcomes (Estabrooks et al., 2009; Wright et al., 2013) and one study found that body fat was negatively correlated to use of an email facility to counsellors, quiz results, and weight self-monitoring (Williamson et al., 2005). Conversely, lower usage rates may therefore have impacted on the effectiveness of the interventions in this review. The extent of such an effect is difficult to determine as the remaining studies did not report on the differential outcomes of high users compared to low users. It is also difficult to ascertain if those who utilize an intervention more do so because they are more motivated and therefore results of comparisons between high and low users may not necessarily be indicative of the effect of the intervention itself (Estabrooks et al., 2009). None of the previous eHealth or parent-focused childhood obesity systematic reviews have specifically addressed the effect of usage rates on outcomes, however, it has been demonstrated in a previous systematic review on general eHealth interventions that adherence to weight-related eHealth interventions is associated with positive outcomes (Donkin et al., 2011).

Most of the studies in this current review used an eHealth modality combined with face-to face, telephone, group sessions, workbooks or camp activities (Baranowski et al., 2003; Davis et al., 2013; Estabrooks et al., 2009; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013). Only one intervention used eHealth as the sole mode and interestingly, this was the only intervention to demonstrate a significant difference between groups in an anthropometric measure at the end of the intervention, with participants in the intervention group achieving a significant reduction in waist-to-hip ratio compared to the control group (Chen et al., 2011). In regard to the studies that employed other modes in addition to the eHealth mode, in most cases it was not possible to isolate the effects of the eHealth mode and therefore the exact effect of the eHealth component could not be determined. A previous parent-focused childhood obesity systematic review found that interventions where parents received only one delivery mode produced better outcomes than interventions with more than one mode of delivery. The authors speculated that the parents may have found the intervention to be too complex when more than one mode was used (Yavuz et al., 2015) and it is possible that this may have been the case for other studies included in this current review. Previous eHealth childhood or adolescent obesity systematic reviews have discussed isolating the effects of the eHealth intervention either only briefly or not at all. Nguyen et al (2011) found that out of the 24 studies reviewed, only six employed eHealth as the sole mode and four of these six studies resulted in significant improvements in BMI, BMI *z*-score or obesity-related behaviors (Nguyen et al., 2011).

The level of parent and child or adolescent involvement in the interventions varied, but seven of the eight interventions involved the children or adolescents to some degree (Baranowski et al., 2003; Chen et al., 2011; Davis et al., 2013; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013). Only one of the studies delivered the intervention solely to the parent (Estabrooks et al., 2009). Interestingly, this was the study which was found to have the largest effect size. However, due to the small number of studies included, it is difficult to draw any conclusions from this, particularly given that the result was not statistically significant. This is similar to findings from previous parent-focused childhood or adolescent obesity systematic reviews, most of which have found that parent-focused interventions have demonstrated better outcomes than interventions where there was either no parent involvement or it was optional (Ewald et al., 2014; Niemeier et al., 2012; Peirson et al., 2015).

Three studies in the current review were aimed at obesity prevention and did not have being overweight or obese as an inclusion criterion. Baseline BMI or BMI *z*-score was therefore lower in these studies than in studies where obesity treatment was the focus, and this may have been a factor in reporting non-significant findings for BMI outcomes. Understandably, a sub-group analysis indicated a larger effect for obesity treatment studies compared to obesity prevention studies, which confers with a previous parent-focused childhood obesity review which found that interventions largely aimed at obesity prevention did not significantly reduce BMI, but rather prevented increases in BMI (Niemeier et al., 2012). However, both of these types of studies (obesity prevention and treatment) are important.

The eHealth modality used may have been a factor in the success of an intervention, however due to the small number of studies utilizing particular eHealth modalities (only one used telemedicine and two used IVR); a sub-group analysis was not conducted. The systematic review found that four of the five Internet interventions produced positive outcomes in either waist-to-hip ratio, nutrition or physical activity measures. Internet interventions are the widest studied of eHealth modalities and have demonstrated positive effects in other recent reviews on eHealth obesity interventions (Hutchesson et al., 2015; Nguyen et al., 2011).

The effectiveness of the specific content of eHealth interventions on study outcomes has not been specifically addressed in previous eHealth childhood obesity systematic reviews. In adult populations, Internet interventions with additional components such as self-monitoring, feedback, reminders, email counselling, web-based discussion groups, web-based lessons, text messages, social networking or mobile phone apps have been found to be more successful in producing weight loss outcomes. Such components were used to a small extent in the studies included in this review, including monitoring (Chen et al., 2011; Paineau et al., 2008; Williamson et al., 2006), email counselling (Williamson et al., 2006), feedback (Williamson et al., 2006) and reminders (Baranowski et al., 2003). The incorporation of more of these components in future eHealth childhood obesity interventions may assist in improving outcomes.

There were no interventions targeting the early childhood age group (0-5 years) in this review and in general childhood obesity research, there has been a lack of interventions in this age group (Luttikhuis et al., 2009). Overall, parent-focused childhood obesity interventions have been found to be effective in this age group in the short term, particularly where only one mode of intervention is used (Yavuz et al., 2015). It has been proposed that early childhood is the ideal life stage to intervene in the course of childhood obesity as it is a time where new healthy lifestyle practices can be introduced, rather than attempting to change well-established unhealthy practices in older age groups (Natale et al., 2014). At this stage of life, parents are usually the main influence on the nutrition and physical activity practices of their children and therefore the effect of parental influence is likely to be more profound than in older age groups when outside influences become more prominent (Natale et al., 2014). Engaging parents of young children via an eHealth modality may be an appealing format for parent-focused interventions, given that parents in developed countries with children within this age group appear to be tech savvy (as suggested by a high proportion of internet and SMART phone use) (Australian Bureau of Statistics, 2016b; Australian Communications and Media Authority, 2014; File & Ryan, 2014; Pew Research Center, 2015).

There were only a small number of studies found over the 20-year period included in this meta-analysis, demonstrating that this field of study has not been well investigated, despite the dramatic advances and acceptability in technology. eHealth in childhood or adolescent obesity is only a relatively new area; a 2010 systematic review found only 21 studies and only 11 of these were RCTs (Nguyen et al., 2011). In this current parent-focused review, there was only one study found that was over 10 years old.

The quality of the interventions were generally not high, with the areas of randomization, blinded outcome assessment, valid measurement of BMI, and adjusted difference between groups either not being described or adequately carried out in a number of studies. The results should therefore be interpreted with caution due to potential bias. This is a similar finding to a previous eHealth childhood obesity review (Nguyen et al., 2011).

2.4.4.1 Strengths and limitations

The strengths of this meta-analysis and systematic review include adherence to a registered study protocol and rigorous use of the PRISMA statement. A detailed search strategy was utilized over several databases with a wide date range, and strict inclusion criteria were applied during the study selection process. To the author's knowledge, this review is the first to quantitatively measure the effects of parent-focused eHealth childhood or adolescent obesity interventions on BMI or BMI *z*-score. Limitations of this review include the restriction to articles published only in English, the small number of RCTs found, varying study quality, heterogeneity of the studies, inadequate power to detect an outcome in some studies due to a small number of participants, inability to isolate the effects of the eHealth component of the intervention in most studies, varying aims between studies (with some studies focusing on obesity prevention and others on obesity treatment) and all but one study being conducted in the United States.

In regard to the meta-analysis, as previously stated in the results, there was an outlying study which favored the control group (Baranowski et al., 2003). It should be noted that this study reported a significant difference in BMI measures at baseline (with the control group having a much larger mean BMI than the intervention group), which may have influenced the results. The planned sub-group analyses comparing the type of eHealth modality used and participant age were not conducted due to the small number of studies and the wide range of ages within the individual studies making it difficult to analyze different age groups. Finally, as there were less than 10 studies in the meta-analysis, a funnel plot analysis was not conducted due to the low power of this test when there are a small number of included studies (Higgins, 2011).

2.4.5 Conclusions

This systematic review and meta-analysis found that there was no significant reduction in BMI or BMI *z*-score resulting from parent-focused eHealth childhood or adolescent obesity interventions compared to control. Only one study found a significant change in weight or adiposity measures (waist-to-hip ratio) and half the studies demonstrated significant improvements in obesity-related behaviors such as diet or physical activity compared with a control group. Only one study used eHealth as the sole modality, making it difficult to determine the true effect of eHealth on obesity. This review highlighted key weaknesses in the current literature: most studies were generally not of high quality, many had a short duration and lack of long-term follow-up and many included only a small number of participants; and therefore, they may have been inadequately powered. There was an absence of studies which included children aged younger than five years, an age group where parental influence is probably more profound than older childhood and adolescence. It is therefore recommended that larger, high-quality studies of longer duration and longer follow-up are conducted, which transform successful components from face-to-face interventions into an eHealth format, particularly those which target younger age groups.

2.5 Extended systematic review and meta-analysis

Two additional studies, which met the criteria of the review have been published since the completion of the systematic review and meta-analysis (i.e. since April 2015). These articles were identified using the same databases and search terms that were used for the systematic review and meta-analysis.

2.5.1 Results

2.5.1.1 Description of studies

The characteristics of these studies are outlined in **Table 2.4**. One study was conducted in the USA and one in The Netherlands. The total number of dyads for these latter studies were 2175 (73 in Wald et al (2018) and 2102 in van Grieken et al (2017) and included Dutch (van Grieken et al., 2017), Hispanic and African American (Wald et al., 2018) cultural/ethic groups. The study by Wald et al (2018) only included overweight and obese children, whilst the van Grieken et al (2017) study included healthy weight as well as overweight and obese children. The overall gender proportions in the studies were approximately 50% girls. The participating parent in the Wald et al (2018) study was the mother. Parent gender was not explicitly reported in the van Grieken et al (2017) study, however it was reported that the mother completed the questionnaires in over 70% of cases. Children in the van Grieken et al (2017) study were aged 18-24 months and the Wald et al (2018) study included children aged 3-7 years. The van Grieken et al (2017) study was conducted between 18 and 24 months of age with a 36-month follow up and the Wald et al (2018) study was 12 months in duration with no follow-up period. The retention rate at the 36-month follow-up for the van Grieken et al (2017) study was 73% and the retention rate at the 12-month time-point for the Wald et al (2018) study was 45%.

There are similarities and differences between the two new studies and those in the published systematic review and meta-analysis. The age of participants in both new studies was much younger than previous studies (which all targeted children 5 years and over). The duration of both studies was similar to some previous studies. The number of participants in the van Grieken et al (2017) study was similar to past studies; however, the Wald et al (2018) study recruited over twice the number of participants as the previous largest study. The retention rate of the van Grieken study et al (2017) study was similar to previous studies, but was much lower for the Wald et al (2018) study. Finally, the van Grieken et al study (2017) and the Paineau et al (2008) study from the published systematic review and meta-analysis are the only two studies to be conducted outside the USA.

Table 2.4: Summary of parent-focused childhood/adolescent obesity eHealth interventions (April 2015-June 2018)

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
Van Grieken et al 2017, Netherlands	n=2102, 18-24 months old	Based on behavior change theories (Theory of Planned Behavior and Social Cognitive Theory) and information processing theory (McGuire Communication Model). Online adjunct to face-to-face well-child visits consisting of 2 modules at 18 and 24 months on healthy eating and physical activity and two reminders.	Parent-only intervention	Dietary intake (breakfast, sweetened beverages), physical activity, TV viewing and computer use	Demographics, breakfast consumption, physical activity, sweetened drink intake, TV viewing and computer use (parent-reported questionnaire), BMI, BMI SDS (measured by youth health care professional), website usability.	No significant results for BMI or behaviors. There were some significant results in the moderator analyses.
Wald et al 2018, USA	N=73, 3-7 years of age	Consisted of 6 x wkly face-to-face group meeting and group counselling. Also provided with website access (incl discussion group) for 1 year and 3 additional face-to-face visits. Topics included healthy eating, weight gain/loss,	Parent-only intervention	Healthy eating, physical activity and screen-time	Demographics, dietary intake (24-h recall x 2), family eating and activity habits questionnaire, (physical activity, screen-time, eating habits), parent authority questionnaire, parenting	No significant difference in BMI *z*-score between groups, but there was reduction in both groups. Significant decrease in BMI

Author, Year, Country	Participants	Intervention Description	Parental Involvement	Behaviors Targeted	Variables Measured	Key Findings
		physical activity, sedentary behavior, screen-time, parent responsibility and parenting skills. Control group received usual care (annual well-child visit).			sense of competency scale, BMI, BMI *z*-score, website usage.	*z*-score (-0.26 ±0.43, *P*=0.0272) and BMI% (-4.67% ±8.39%, *P*=0.0417) from baseline to month 3 in the intervention group.

BMI – Body Mass Index, SDS – Standard Deviation Score, wkly – weekly.

2.5.1.2 Description of interventions

Both the RCTs had two study arms and both used a web-based intervention in addition to face-to-face sessions. The face-to-face sessions were individual in the van Grieken et al (2017) study and group-based in the Wald et al (2018) study. Both studies focused on healthy eating, physical activity and screen-time behaviors; additionally the Wald et al (2018) study focused on general parenting skills. van Grieken et al (2017) based their intervention on Social Cognitive Theory and the Theory of Planned Behavior as well as an information processing theory known as the McGuire Communication Model. Use of theory was not reported by Wald et al (2018). Both studies used BMI and BMI *z*-score as the measure of adiposity. Other measures included dietary intake assessments such as 24-hour recalls (Wald et al., 2018) and questionnaires (van Grieken et al., 2017; Wald et al., 2018), physical activity and screen-time questionnaires (van Grieken et al., 2017; Wald et al., 2018) and parenting questionnaires (Wald et al., 2018).

2.5.1.3 Risk of bias

The risk of bias assessment for the two additional studies is summarized in **Table 2.5**. Both studies reported key baseline characteristics for each study arm, used intention-to-treat analyses for BMI outcomes and reported power calculations. Only van Grieken et al (2017) described a valid and standardized method of BMI measurement, had an acceptable dropout rate, accounted for covariates in the analyses and reported summary results with Confidence Intervals for each group adjusting for covariates. Only Wald et al (2018) described an adequate randomization procedure.

Table 2.5: Risk of bias assessment in randomized controlled trials assessing BMI outcomes of parent-focused eHealth overweight and obesity interventions (April 2015-June 2018)

Study	Van Grieken et al 2017	Wald et al 2018
Baseline characteristics by group	+	+
Randomization described and conducted	-	+
Valid measurement of BMI	+	-
Drop out ≤20% for <6 months and ≤30% for ≥6 months	+	-
Blinded outcome assessment	-	-
Intention-to-treat for BMI outcomes	+	+
Covariates accounted for in analysis	+	-
Summary results + adjusted difference between groups + CI	+	-
Power calculation reported and power adequate	+	+

+ Adequately described and present, - absent.

2.5.1.4 Results of individual studies

2.5.1.4.1 Adiposity outcomes

None of the studies reported a significant difference in BMI or BMI *z*-score between groups. One study reported a significant reduction in BMI *z*-score (-0.26 ±0.43, P=0.0272) and BMI% (-4.67% ±8.39%, P=0.0417) from baseline to 3-months in the intervention group, but this change was not maintained at the end of the intervention.

2.5.1.4.2 Other outcomes

There were no significant differences between groups over time in relation to any other outcomes measured in either study.

2.5.1.5 Updated synthesis of results

Data from the Wald et al (2018) study was added to the previously conducted meta-analysis. Due to lack of information available on the number of participants with BMI measures collected, data from the van Grieken et al (2017) study was not able to be included. A meta-analysis was therefore repeated on pooled data from nine papers with a total of 10 study arms, comparing the eHealth intervention and control groups. The meta-analysis results are displayed in **Figure 2.3**. No differences were reported for the repeated meta-analysis. Like the original meta-analysis, the studies were again found to be significantly heterogeneous (I2=82%, 95% CI: 68%-90%, P<.001) and there was no significant difference in the effects of the eHealth interventions compared with the control groups on BMI/BMI z-score (SMD −0.13, 95% CI: −0.42 to 0.16, Z=0.87, P=0.38).

The Wald et al (2018) was included in the obesity treatment sub-group analysis (refer to **Figure 2.3**). A larger effect remained for the obesity treatment studies (−0.32, 95% CI −0.84 to 0.21) compared with the obesity prevention studies (0.05, 95% CI −0.19 to 0.30), although not statistically significant. A higher level of heterogeneity remained for the obesity treatment studies (83%) compared to the obesity prevention studies (63%). As only one additional study was included in this repeat meta-analysis and the numbers remain small, the results should still be interpreted with caution.

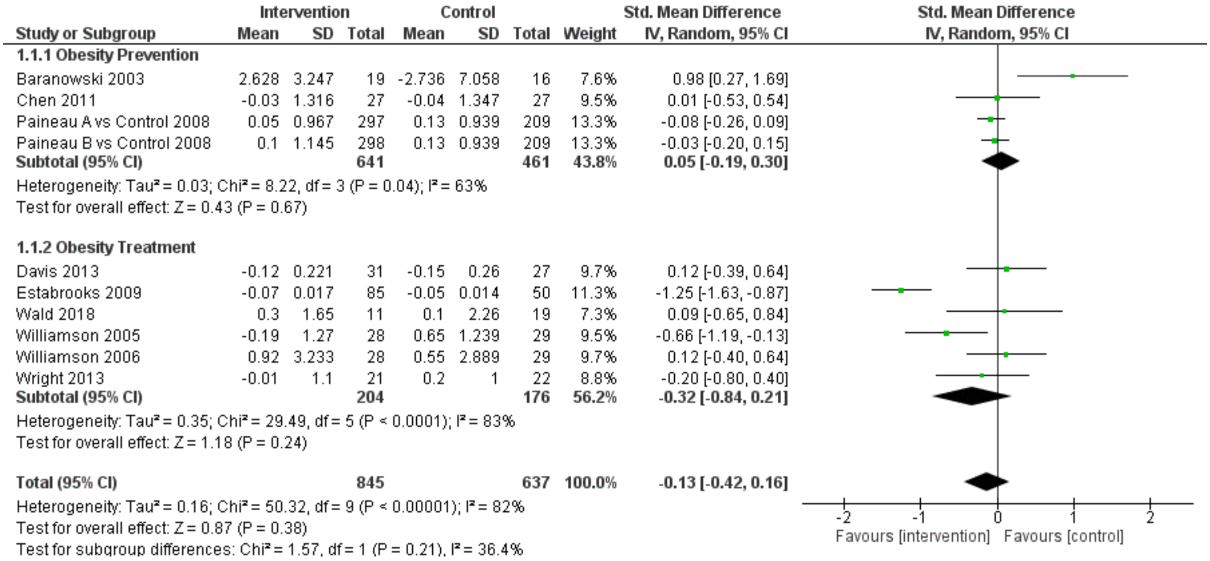


Figure 2.3: Effect of eHealth interventions on BMI or BMI *z*-score (updated to June 2018).

2.5.2 Discussion

The two additional studies that have been published since the systematic review and meta-analysis demonstrate similar BMI/BMI *z*-score results to the previous studies, with neither study reporting a significant improvement in BMI/BMI *z*-score between groups. The results of the updated meta-analysis were therefore similar to the original. However, contrary to half of the studies in the original systematic review and meta-analysis, neither of the two studies reported significant results for any dietary intake or physical activity measures. The number of participants lost to follow-up in one of these studies was over 50%, much higher than the other studies (Wald et al., 2018). The quality of the two interventions, like those in the systematic review and meta-analysis was generally not high, with blinded outcome assessment being particularly poor, although reporting of baseline characteristics by group, intention-to-treat analyses and power calculations were sound.

One of the main gaps identified in the published systematic review and meta-analysis was the absence of studies in children younger than 5 years of age, so it is pleasing that both the studies published since then have been in this age group. Both studies involved a face-to-face and an eHealth component. A previous parent-focused systematic review of childhood obesity interventions found that better outcomes were achieved with only one mode of delivery compared to more than one (Yavuz et al., 2015). The most successful intervention (Chen et al., 2011) from the current systematic review and meta-analysis used eHealth as the sole mode of delivery; it would be interesting to investigate if similar results could be obtained from a sole eHealth intervention in a younger age group.

2.5.3 Conclusions

This chapter was prefaced by background information on childhood overweight and obesity, including the prevalence, and factors that influence overweight and obesity followed by a published systematic review and meta-analysis which reviewed the evidence for BMI/BMI *z*-score improvements in eHealth overweight and obesity RCTs for children and adolescents, where parents or carers were an agent of change. Finally, a discussion was provided on the literature published since the original searches were conducted.

No parent-focused eHealth study to date has found a significant reduction in BMI or BMI *z*-score and just under half the studies demonstrated significant improvements in dietary intake or physical activity measures. The following gaps in research have been identified:

- Many studies were of poor quality and at risk of bias
- Many studies had a disappointing retention rate
- Use of theory was reported in just over half of studies and details provided on alignment of the intervention to theory was limited
- Some studies had a short duration and most had no follow-up period
- No study to date has targeted dietary intake, physical activity, screen-time and sleep
- Only one study has used eHealth as the sole mode of delivery
- No studies have incorporated a social media component
- Only two studies have been conducted outside the USA
- There are only two studies to date which have targeted children under the age of five, an age when parental influence is significant. Only one of these studies has been in the preschool age group.

It is therefore recommended that further research be implemented in the preschool age group. Higher quality interventions should be conducted which are designed to align intervention activities to behavior change theory. It is also suggested that interventions explore opportunities to maximize retention rates. Trialing the use of an intervention which uses eHealth as the sole mode of delivery is suggested, as parents may find it easier to maintain engagement with an intervention which has a lower level of complexity, offers more flexibility and requires less time and travel commitments.

The *Time2bHealthy* RCT was specifically designed to address gaps in previous studies by:

- Targeting preschool-aged children

- Addressing multiple obesity-related behaviors
- Aligning intervention activities and target behaviors to theory
- Conducting thorough intervention planning to ensure high methodological quality
- Using eHealth as the sole mode of delivery
- Incorporating a social media component
- Including a follow-up period

The research aim of this thesis, therefore, was to investigate the efficacy of the *Time2bHealthy* online program in facilitating behavior change among preschool-aged children who are overweight, or at risk of becoming overweight. More specifically, the research questions were:

Primary research question:

1. What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on child BMI?

Sub research questions:

1.1 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on child:

a) Dietary intake (energy intake, sugar intake, saturated fat intake, fruit and vegetable intake, discretionary food intake and sugar-sweetened beverage intake)
b) Physical activity and sedentary time
c) Screen-time

d) Sleep

1.2 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on parental role-modelling and parent self-efficacy in the above behaviors?

1.3 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on parent child feeding beliefs and practices?

1.4 Was the intervention effect on BMI change mediated by changes in obesity-related variables or moderated by baseline participant characteristics?

1.5 Did participants who highly engaged in the Facebook discussion group achieve superior outcomes to participants with a lower level of engagement?

The next chapter will present the published methods of a RCT for the *Time2bHealthy* online healthy lifestyle program for parents of preschool-aged children, the intervention which aimed to fill the gaps identified in this literature review.

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Chapter 3

Methods

This chapter outlines the methods used for this research, incorporating the study design, participant recruitment and eligibility criteria, intervention mapping process, theoretical framework, outcome measures and the statistical analysis method. The chapter also describes the strengths, risks and limitations of the study design.

This chapter has been published as: Hammersley ML, Jones RA, Okely AD (2017). *Time2bHealthy* – An online childhood obesity prevention program for preschool-aged children: A randomised controlled trial protocol. *Contemporary Clinical Trials*. 61:73-80. doi: 10.1016/j.cct.2017.07.022

3.1 Introduction

Overweight and obesity in early childhood is associated with a range of short- and long-term health consequences. Furthermore, overweight children have at least twice the risk of remaining overweight into their adult life compared to children in the healthy weight range (Luttikhuis et al., 2009). Effective weight management interventions can reduce the likelihood of childhood overweight and obesity continuing into adulthood. Increasing physical activity and improving eating behaviors are recognized cornerstone weight management strategies (Luttikhuis et al., 2009; National Health and Medical Research Council of Australia, 2013b). There is also increasing evidence regarding the importance of limiting screen-time (Hinkley et al., 2012b), reducing sedentary activities (Okely & Jones, 2011; Reilly, 2008) and maintaining healthy sleeping patterns (Cappuccio et al., 2008; Fatima et al., 2016; Thind, 2014).

Parental influence and role-modelling play a key part in the development of such behaviors (Golley et al., 2011; Natale et al., 2014; Niemeier et al., 2012). Therefore, the role of parents in overweight and obesity prevention and intervention programs is critical. Previous reviews have highlighted the success of interventions which involve parents compared to those that do not (Grimes-Robison & Evans, 2008; Ho et al., 2012b; Young et al., 2007). This is particularly true for programs that target young children. Despite the importance of parental involvement in overweight and obesity prevention and treatment programs, there are recognized barriers such as scheduling of appointments/sessions (Grimes-Robison & Evans, 2008), stigma, parental denial (Kelleher et al., 2017), childcare for other siblings (Warren et al., 2007), travel (Fitch et al., 2013) and cost (Grimes-Robison & Evans, 2008) that prevent parental involvement and potential success of the programs.

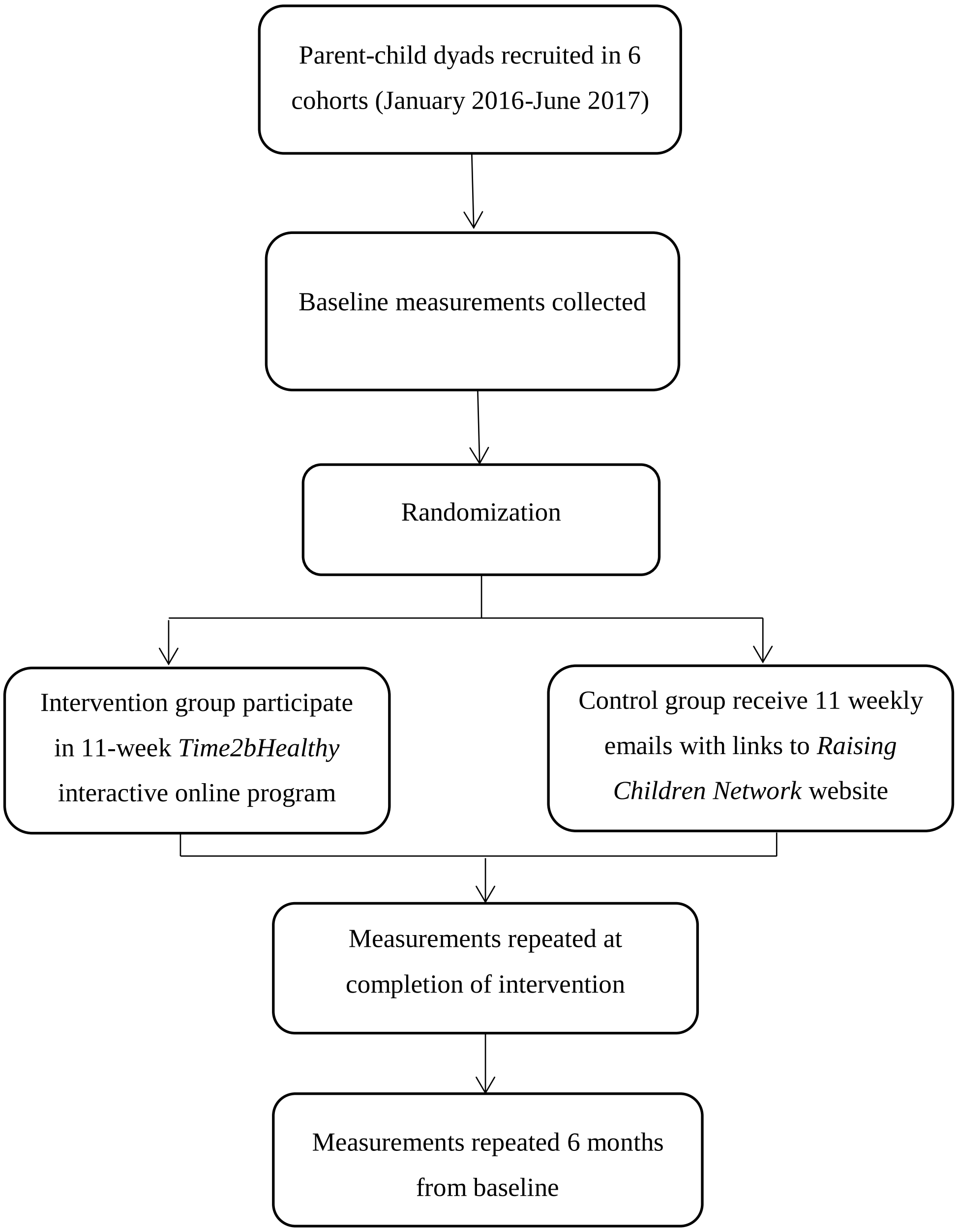
The use of the online medium for overweight and obesity prevention and treatment programs offers advantages compared to face-to-face programs in convenience and accessibility. There have been an increasing number of online healthy lifestyle interventions for children in recent years. Systematic reviews have demonstrated that such interventions are efficacious in improving obesity-related behaviors and are cost effective, however the majority of studies have been conducted in the primary- or high-school age groups and most have not involved parents as an agent of change (An et al., 2009; Hammersley, Jones, & Okely, 2016; Nguyen, Kornman & Baur, 2011). A recent meta-analysis of parent-focused eHealth obesity interventions found that while there was no significant effect found in BMI/BMI *z*-score change, half the studies demonstrated significant improvements in obesity-related behaviors such as diet or physical activity compared to a control group (Hammersley et al., 2016). In this review there was an absence of studies which included children under the age of five years (Hammersley et al., 2016), an age group where parental influence is arguably more profound than older childhood and adolescence (Natale et al., 2014). It was therefore recommended that larger, high quality studies be conducted which transform successful components from face-to-face interventions into an eHealth format, particularly those which target younger age groups and focus on parents as agents of change (Hammersley et al., 2016). The aim of this paper was to describe the protocol for the *Time2bHealthy* Study. The purpose of the study was to determine the efficacy of the parent-focused *Time2bHealthy* online program in facilitating behavior change among preschool-aged children who were overweight, or at risk of becoming overweight. The primary hypothesis was that children in the intervention group would demonstrate significantly greater reductions in BMI compared to the comparison group by the 6-month follow-up. Secondary outcomes including child dietary intake, physical activity, screen-time, sleep and parent self-efficacy were also assessed.

3.2 Methods

3.2.1 Study design

The *Time2bHealthy* study was a two-arm RCT involving parent-child dyads (**Figure 3.1**). *Time2bHealthy* was based on formative research with parents of preschool-aged children. This research analyzed the content of 300 publicly available websites containing healthy lifestyle information for children of preschool age and found that the websites lacked strategies on how to practically apply the information and set goals to assist in changing behaviors. Focus group results from this research similarly indicated that parents would find information of how to implement changes helpful. Parents also advised that an online program would need to be easy to use and be flexible and highly credible. Personalized feedback from a health professional was also important to parents (Jones, Price, Okely, & Lockyer, 2009).

Figure 3.1: *Time2bHealthy* study design



Based on the results of this research, a 10-week, five-module online program – *Time2bHealthy* - was developed which covered the areas of healthy meals, healthy snacks and drinks, physical activity and screen-time. The program was piloted with 47 dyads and was found to be acceptable, potentially efficacious and had a high level of retention (Jones, Wells, Okely, Lockyer & Walton, 2011) and a RCT was required to fully test the efficacy of the intervention. Due to more recent research into the effects of sleep on overweight and obesity in children, an additional module on sleep was added to the program for the current trial. Content of the modules was also updated according to the latest evidence-based recommendations (Australian Government Department of Health, 2014; Hirshkowitz et al., 2015; National Health and Medical Research Council of Australia, 2013a),additional content was added and the behavior change and goal setting aspects of the program were strengthened. Specific details on the changes made to the program prior to the implementation of the RCT are outlined in **Appendix H**.

The study was reported according to the Consolidated Standards of Reporting Trials (CONSORT) statement (Schulz, Altman & Moher, 2010). The study was approved by the University of Wollongong Human Research Ethics Committee (HE15/354) and registered with the Australian and New Zealand Clinical Trials Registry (12616000119493).

3.2.2 Participant recruitment and eligibility criteria

Participants were recruited from the Illawarra, Southern and South-Western Sydney, Southern Highlands and Shoalhaven areas of New South Wales and Melbourne, Victoria in Australia. To assist with recruitment, organizations and individuals such as early childhood education centers, schools, playgroups, general practices, early childhood nurses, preschool swimming and sporting activities were contacted and asked to distribute flyers and/or display posters. Articles were placed in university and local health district newsletters, a Facebook page was created to communicate information about the study throughout the recruitment areas and a media release was sent to media agencies.

Potential participants were provided with a participant information sheet and screened for eligibility via phone or email. Participants were eligible if they lived in one of the geographical areas described, the child was 2-5 years of age and not yet attending school at the time of recruitment and the child was at or above the WHO 50th percentile for BMI for their age and sex. Parents were also required to have a Facebook account or were willing to create one for the duration of the study.

Child participants were excluded if they were taking medications or had a medical condition that can affect weight. As such, children were excluded if they were taking any of the following medications: Ritalin or other therapy for attention deficit hyperactivity disorder, long-term steroids, anti-psychotic medication. Furthermore, children were excluded if they had any of the following conditions or disabilities: Prader-Willi Syndrome, Bardet-Biedl Syndrome, diabetes, phenylketonuria or other metabolic disorders, cystic fibrosis, significant physical or developmental disability (that restricts age-appropriate play) or other conditions associated with overweight/obesity. Children with conditions such as coeliac disease or food allergies were able to participate, but parents were informed that some of the healthy eating content of the program would not be entirely appropriate and they would need to make their own modifications to some of the information provided to suit their child's specific dietary requirements.

Eligible participants provided informed consent after reading the participant information sheet by completing a written consent form. Eligibility was confirmed at the baseline data collection visit when child height and weight were measured and BMI was calculated to determine if the child was at or above the WHO 50th percentile for age and sex. Recruitment commenced in January 2016, with participants being recruited into six cohorts on a rolling basis. Recruitment was completed in June 2017.

3.2.3 Power and sample size

We expected an effect size for BMI (the primary outcome) of approximately 0.4 for this trial (SD=4.1) based on the results of the pilot study. To detect a statistically significant difference between groups (alpha=0.05 and power=0.8), 136 participants were required (68 per group) and considering an estimated attrition rate of 15%, it was planned for 160 participants to be recruited (80 per group).

3.2.4 Randomization

Once participants were recruited and baseline measures were collected for each cohort, participants were randomized into the intervention or comparison group. Randomization was conducted by a data manager using a concealed computerized random number generator. The data manager was not involved in the recruitment or delivery of the intervention. Results of the randomization were then communicated to the researcher responsible for implementing the intervention. Height, weight, physical activity, dietary intake, sleep, screen-time, parental modelling and self-efficacy were assessed at baseline, post-intervention (3-months) and 6-month follow-up. Baseline data collection was completed prior to randomization, so data collectors were blinded to group allocation. At post-intervention and 6-month follow-up data collection time-points accelerometers were fitted and questions on dietary intake, sleep, screen-time, role-modelling and parent self-efficacy were entered directly into an iPad by the participants. Height and weight measurements at the follow-up time-points were taken by data collectors who were blinded to group allocation.

3.2.5 Theoretical framework

The intervention was guided by Bandura's Social Cognitive Theory, which proposes that there are three influences on behavior: personal, behavioral and environmental (which is also known as reciprocal determinism) (Bandura, 1986). The interaction of the personal, environmental and behavioral influences within the *Time2bHealthy* intervention are illustrated in **Figure 3.2**.

- Personal influence refers to an individual's self-efficacy (or their personal belief in their ability) to carry out a behavior. This is based on their personality, knowledge, beliefs, self-perceptions and expectations. Knowledge and beliefs of the importance of healthy eating, physical activity, sleep and limiting screen-time for preschool-aged children were addressed through the program content of the modules.
- Environmental influence refers to supportive environments which assist an individual to carry out a behavior. An individual is influenced by physical and societal influences in the environment. Videos demonstrating effective use of skills and behaviors by others provided participants with vicarious learning. Communication, feedback and reinforcement from other participants via the

Facebook group and from research staff via individualized communication also assisted in supporting participants in practising the skills and behaviors.

- Behavioral influence refers to the response by the individual once they have practised carrying out a behavior. This experience determines how often and how well they carry out a behavior. After setting SMART goals (specific, measurable, achievable, realistic and time-framed) (Locke & Latham, 2002) and action plans, participants practiced the skills and behaviors. Positive reinforcement was gained through the monitoring of progress with their goals and action plans and the personal benefits experienced.

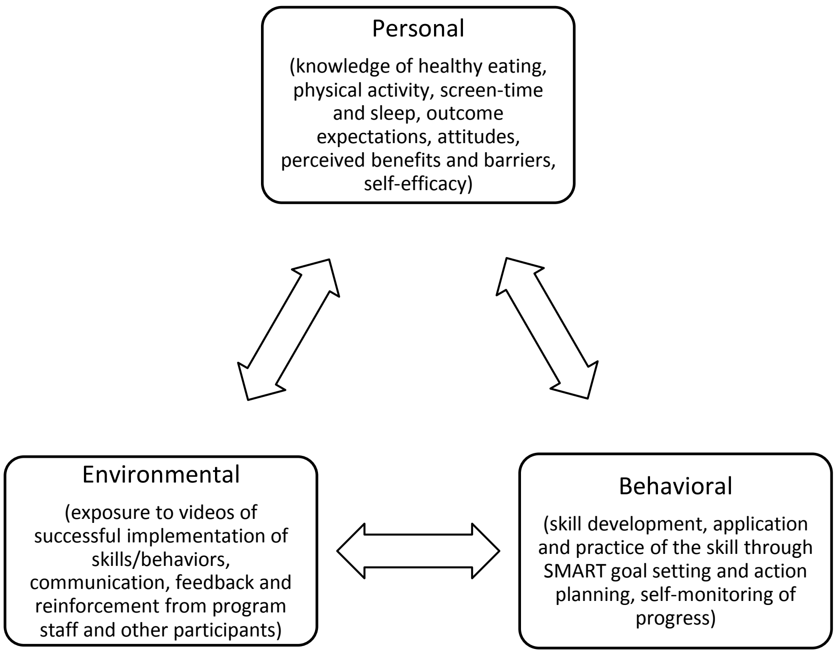


Figure 3.2: Personal, environmental and behavioral influences within the *Time2bHealthy* program

The intervention addressed the four key processes of Social Cognitive Theory for learning and adapting new behaviors: attention, retention, production and motivation (Bandura, 1986). Attention was addressed by ensuring that the website was easy to use and contained interactive evidence-based components (videos, activities and goal setting), so participants were engaged. Retention was supported through an optimal length for the program, interaction with other participants through the closed Facebook group and quizzes to support parents in remembering the key content from each module. Production was addressed through goal setting, action planning, addressing barriers and behavior rehearsal. Motivation was addressed through creating cognitive dissonance by parents documenting current behaviors (e.g., in the activity planner) and asking parents to identify the positive outcomes and expectations as a result of performing the planned actions. Throughout the goal setting process, parents were asked about their motivation to make a change and SMART goals (Locke & Latham, 2002) were set, where parents were asked to make challenging, yet realistic goals.

3.2.6 Intervention development

A backwards intervention mapping process was utilized in designing the study to align the *Time2bHealthy* intervention activities to the theory and target behaviors (developed by Robinson (Cornelius et al., 2014; Robinson & Borzekowski, 2006)). This process involved determining the overall goal first and then working backwards to identify the major and sub-categories, the target behaviors needed to achieve these and strategies based around the elements of Social Cognitive Theory that can be applied to support the theory. **Figures 3.3 to 3.6** illustrate this process for all components of the intervention.

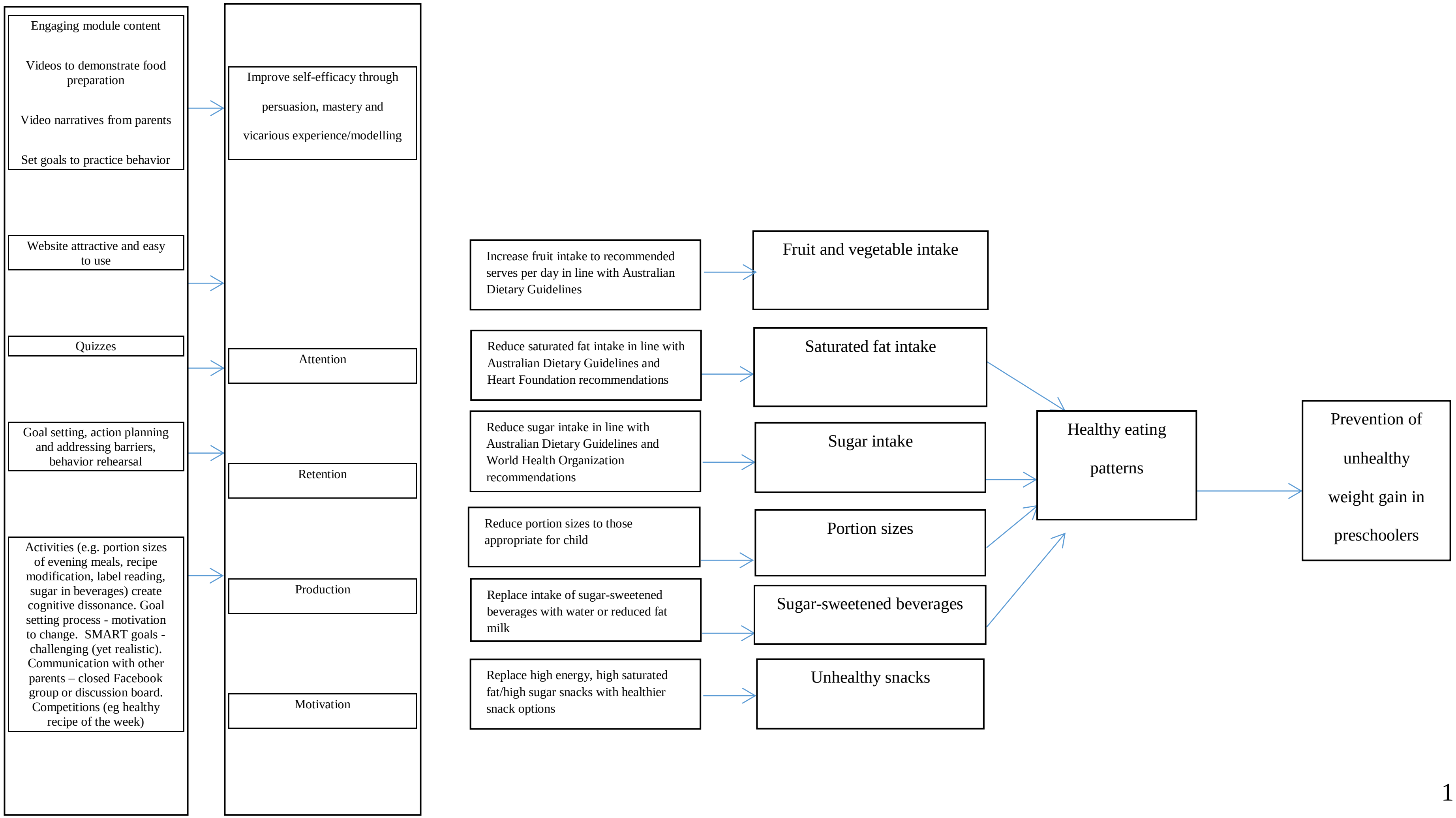


Figure 3.3: Backwards intervention mapping process used in the development of the *Time2bHealthy* healthy eating modules

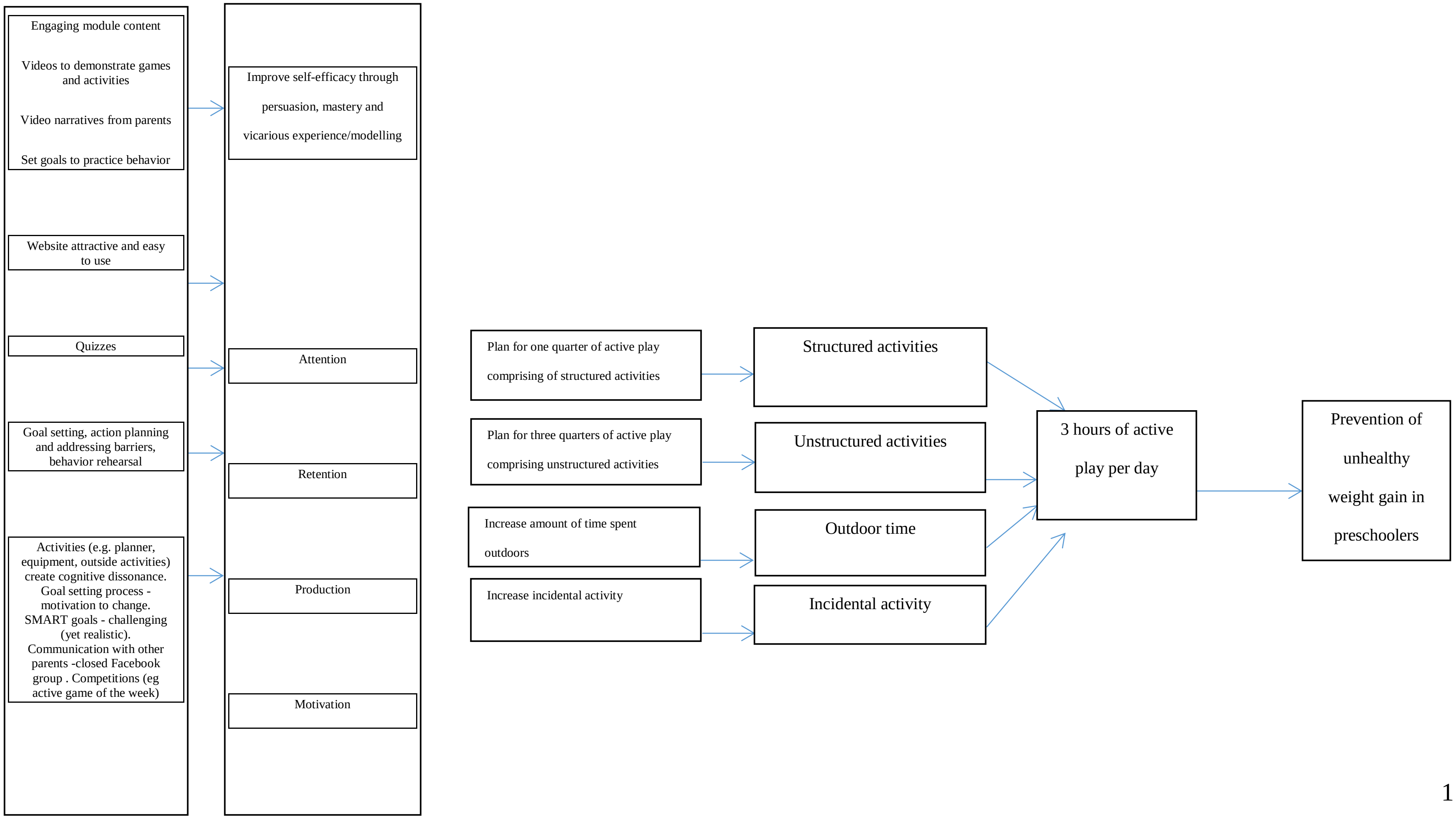


Figure 3.4: Backwards intervention mapping process used in the development of the *Time2bHealthy* physical activity module

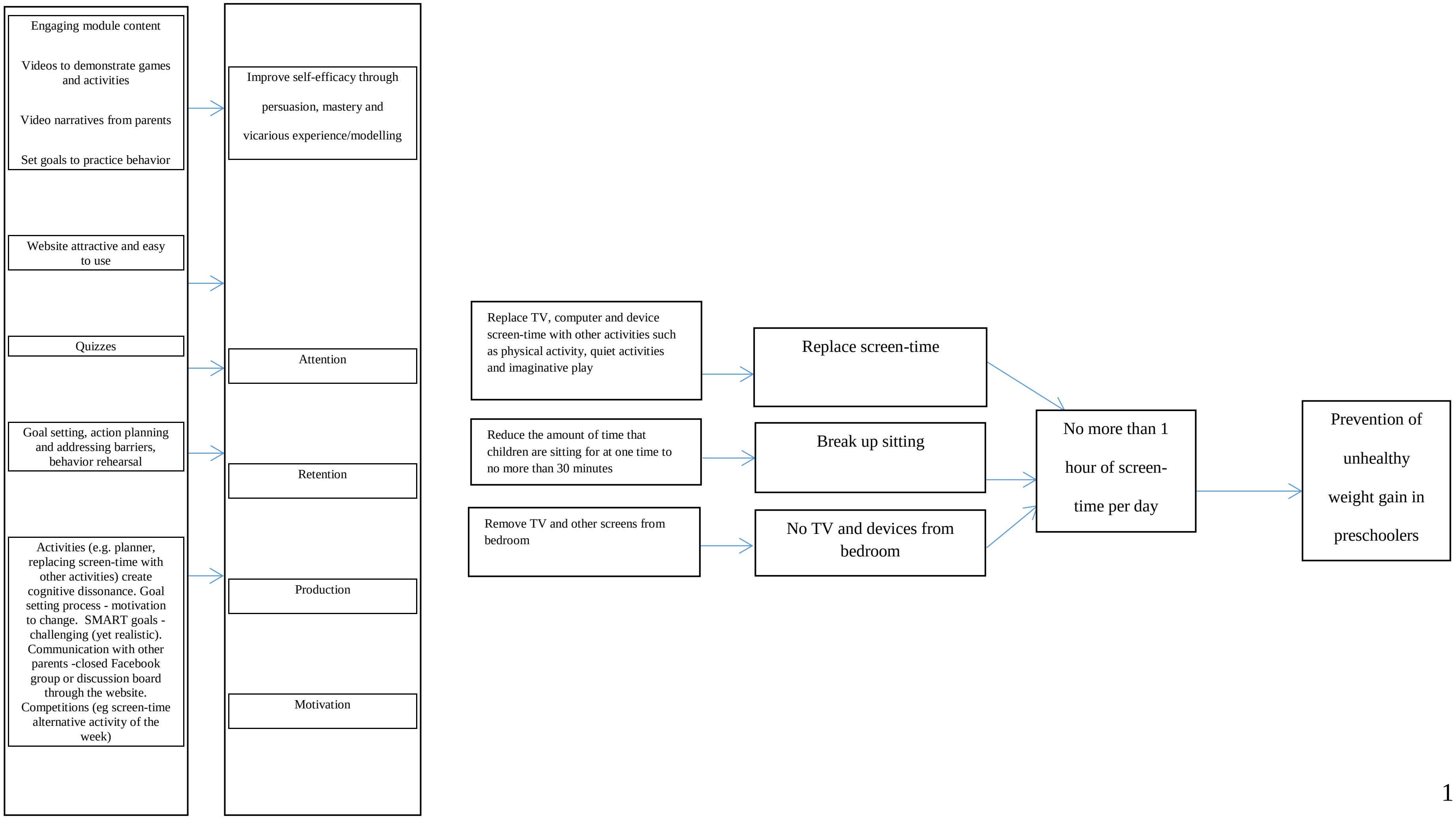


Figure 3.5: Backwards intervention mapping process used in the development of the *Time2bHealthy* screen-time module

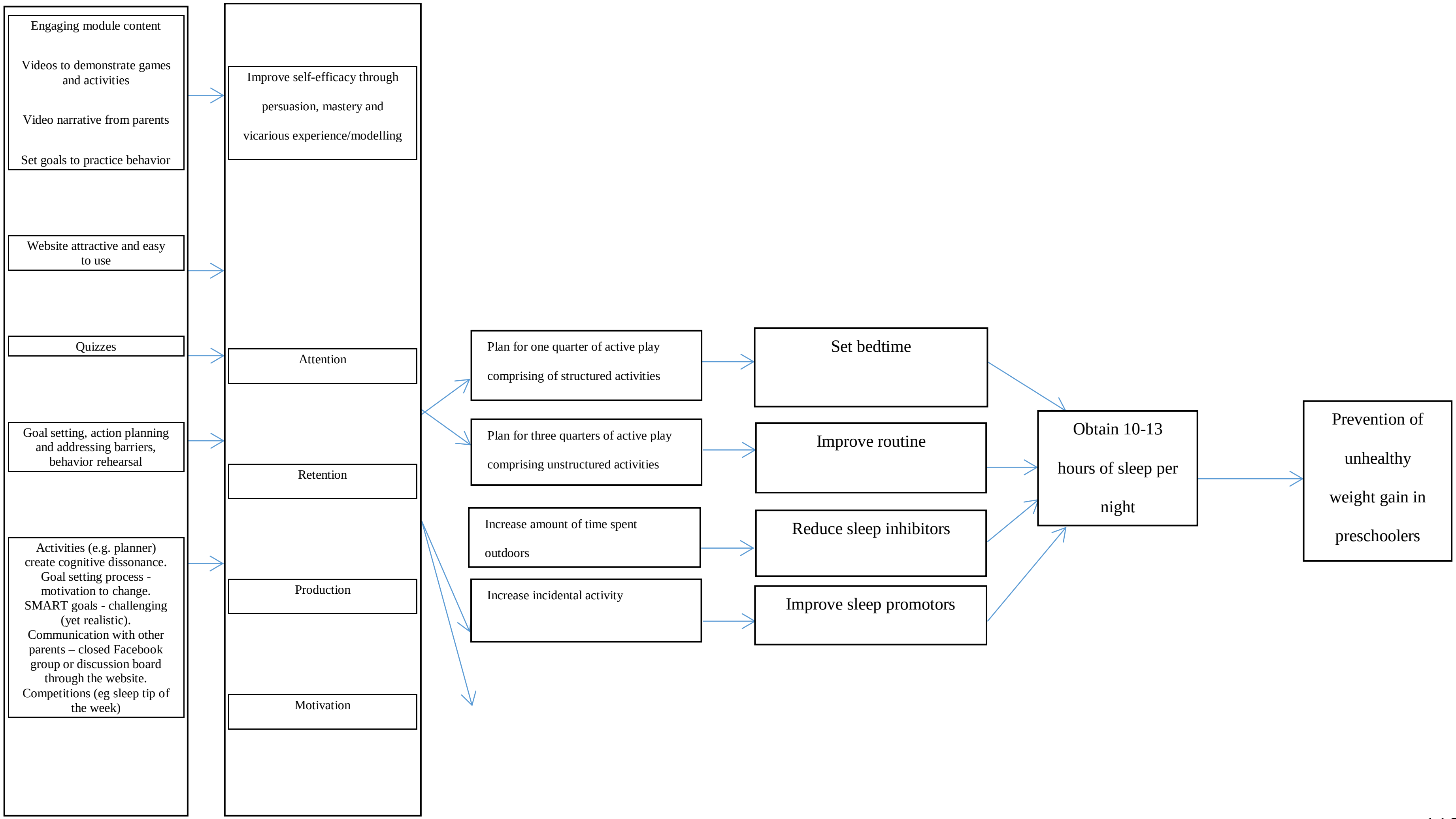


Figure 3.6: Backwards intervention mapping process used in the development of the *Time2bHealthy* sleep module

Table 3.1 outlines the components of each of the modules of the *Time2bHealthy* online program. The content was based on evidence-based guidelines and recommendations for dietary intake, physical activity, screen-time and sleep. Further details of the program content are outlined in **Appendix H**.

3.2.6.1 *Time2bHealthy* intervention

Participants randomized into the intervention group were sent an email with the link to the *Time2bHealthy* website, a unique login and password, information to orient them to the website and details on how to access the Facebook group. Participants were encouraged to contact the research team at any stage if they had any questions or issues accessing or navigating the website. Participants were informed that they were able to go back to previous modules to review content if they wished to.

Time2bHealthy consisted of 6 modules on topics including nutrition (n=2), physical activity, screen-time and sleep and was delivered over a period of 11 weeks. Each module took approximately 30 minutes to complete. Participants were encouraged to complete the first introductory module within the first week and each subsequent module over a two-week period. Each module became accessible to participants following the completion of the previous one. The modules involved participants reading text on each topic, watching videos, completing activities and setting goals. Goal setting and subsequent revision of goals has been demonstrated to be important in the success of lifestyle behavior change interventions (Estabrooks et al., 2005; Jones et al., 2011; Nothwehr & Yang, 2007). Feedback was provided by a dietitian via the website regarding the goals set, with advice provided to enhance the goals in line with the SMART goal framework (Locke & Latham, 2002). Additionally, participants received regular emails to remind them to log on to the website, aimed to assist with participant retention. A closed (secret) Facebook group was accessible, where participants had the opportunity to communicate with other members of the cohort as well as the dietitian. The Facebook group was regularly monitored and moderated by the dietitian to ensure that the information discussed was consistent with evidence-based guidelines. Participants were asked to provide regular input to these groups by sharing healthy recipes/photos of meals, healthy snacks, suitable physical activities and personal ideas and experiences in regard to reducing screen-time and improving sleep. Incentives (either shopping gift cards or vouchers to a children's museum) were provided in return for the time taken for participants to contribute this input.

At the end of the online program at 11-weeks, participants continued to receive fortnightly contact via email. These emails contained infographics which provided a summary of the content from the online program and directed participants to re-visit the online program to review material and their progress with goals set.

3.2.6.2 Comparison condition

Participants assigned to the comparison group received fortnightly emails directing them to various topics on the evidence-based, Australian government-funded parenting website: *Raising Children Network*. The topics provided were of a similar nature to the intervention group (nutrition, physical activity, screen-time and sleep) and other general health topics relevant to the preschool life stage. The content was very brief, consisting of one page of information per week, substantially less than the intervention content. **Appendix I** provides further details regarding the specific topics covered and the links to the Raising Children Network website which were emailed to participants. The comparison group did not have access to any interactive components such as practical activities, goal setting, and individualized feedback. Providing participants in the comparison group with similar topics to the intervention group (rather than alternative content) was an ethical decision to ensure that parents who may have had concerns about their child's weight or general health and wellbeing had access to timely information. Additionally, the comparison group were also offered access to the *Time2bHealthy* program at the completion of the follow-up data collection; however, due to time constraints, these participants did not have access to the Facebook group or receive the regular email contact when they gained access to the *Time2bHealthy* program.

3.2.7 Outcome measures

All measures were collected via face-to-face appointments at the University of Wollongong Early Start building, the participant's home or a community setting, where both parent and child attended. Questionnaires were completed by parents using FileMaker Pro on an iPad. Inputting the data straight into this database negated the need for manual data entry (refer to **Appendix G** for questionnaires which were set up as forms on FileMaker Pro). Parents were first oriented to the iPad and the FileMaker Pro questionnaire forms at the beginning of each appointment and were encouraged to ask the data collector questions if they had any issues inputting the data as they worked through the questionnaires. Appointments were approximately 30-45 minutes in duration. The outcome measures collected are described in **Table 3.2**.

3.2.7.1 Primary outcome measure

BMI was selected as the primary outcome measure, aligning with some similar previous eHealth studies focused on obesity prevention (Baranowski et al., 2003; Chen Weiss, Heyman, Cooper & Lustig, 2011; Paineau et al., 2008). BMI was calculated with height and weight measurements. Height and weight were measured using a standardized method (National Health and Medical Research Council of Australia, 2013b). Height was measured to the nearest 0.1cm using a stadiometer. Weight was measured to the nearest 0.1kg using a SECA scale. Height and weight were measured twice and recorded. An average of the two measurements were then used for BMI calculations. In instances where height measurements differed by more than 0.5cm and weight measurements differed by more than 0.5kg, a third measurement was taken.

3.2.7.2 Secondary outcome measures

3.2.7.2.1 Physical activity

Actigraph GT3X+ accelerometers (ActiGraph Corporation, Pensacola, FL) were used to measure the intensity and amount of physical activity that was occurring over time. The Actigraph GT3X+ accelerometer is a small, light-weight device which records tri-axial movement (up and down, side to side and forward and backward). Accelerometers have been extensively used in physical activity studies in children and they have been validated for use in the preschool age-group (De Vries et al., 2009).

Accelerometers collect very high-frequency raw data (30 Hz) on activity counts, which are stored as epochs in the device and then downloaded for analysis. Cut-points to differentiate physical activity intensity that are appropriate for the preschool age-group were utilized in the analysis (Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006).

All child participants wore an Actigraph accelerometer around the waist on an elasticized belt continuously for a period of seven days (for 24 hours per day), removing them only for a bath/shower or water activities. The accelerometers were fitted to participants at the time of the face-to-face appointments and they were collected from the participant's home or participants returned them in a reply paid envelope. Parents were provided with instructions on how to remove and re-fit the device.

3.2.7.2.2 Sleep

Accelerometers were used to assess sleep habits in conjunction with a questionnaire (Sneddon, Peacock, & Crowley, 2013). A number of recent studies have utilized accelerometers in children for a 24-hour period to assess both sleep and physical activity (Barreira et al., 2015; Katzmarzyk et al., 2013; Kinder et al., 2012; Taylor, Williams, Farmer, & Taylor, 2015).

The questionnaire used consisted of eight questions and was modified from a tool which has been previously validated in the preschool age group (Children's Sleep Habits Questionnaire (Sneddon et al., 2013)) and included questions about typical bedtime and wake up time, typical time and duration of daytime nap and other sleep habits. The information from this questionnaire was utilized in conjunction with accelerometer data to determine sleep duration.

Table 3.1: Components of the *Time2bHealthy* online program

Module	Module Content	Guidelines Informing Content
Module 1 – Introduction	General overview including goal setting, Information on support from dietitian, Information on Facebook group and link, Timetable for program, Weekly planner.	
Module 2 – Healthy Meals	Introduction to healthy eating, How much food?, Serving sizes, Decreasing sugar consumption, How to read labels, Decreasing saturated fat consumption, Increasing fruit and vegetable consumption, Recipe modification, Getting the balance right, Goal setting.	Australian Dietary Guidelines (National Health and Medical Research Council of Australia, 2013a)
Module 3 – Healthy Snacks and Drinks	Why healthy snacks and drinks?, Which snacks and drinks?, What snacks and drinks are consumed in your house?, Healthy snacks and drinks, Choosing snacks and drinks, Goal review, Goal setting.	Australian Dietary Guidelines (National Health and Medical Research Council of Australia, 2013a)
Module 4 – Physical Activity	What is physical activity?, Why do physical activity?, What physical activity is happening now?, How to increase physical activity, Space, Equipment, Creative outside activities, When to increase physical activity, Goal review, Goal setting.	Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (0-5 years) (Australian Government Department of Health, 2014)
Module 5 – Screen-time	What is small screen recreation and how much?, why 1 hour?, How much small screen recreation is happening now?, Too much small screen recreation?, If not small screen recreation then what?, Let their imagination run wild, Active small screen recreation, When can you decrease small screen recreation? Goal review, Goal setting.	Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (0-5 years) (Australian Government Department of Health, 2014)
Module 6 – Sleep	About sleep, What are my child's sleeping patterns now? How long my children should be sleeping for? What can I do?, Persistence with resistance, Improving sleep time, Goal review, Goal setting	National Sleep Foundation Sleep Time Duration Recommendations (Hirshkowitz et al., 2015)

Table 3.2: Outcome measures collected for the *Time2bHealthy* program

Outcome measure	Method	Baseline	Post-intervention	6-month follow-up
Child				
Weight status*	Body mass index	√	√	√
Physical activity	Accelerometer	√	√	√
Child (reported by parent)				
Dietary Intake	Questionnaire (Bennett et al., 2009) and 24-hour recall completed via Easy Diet Diary app	√	√	√
Sleep	Accelerometer and questionnaire (Sneddon et al., 2013)	√	√	√
Screen-time	Questionnaire (Downing et al., 2015; Hinkley et al., 2012a)	√	√	√
Demographics	Questionnaire	√		
Parent				
Self-efficacy	Questionnaire (Bohman et al., 2013)	√	√	√
Parental role-modelling	Modified questionnaire (Gattshall et al., 2008; Palfreyman et al., 2014)	√	√	√
Child feeding	Modified questionnaire (Birch et al., 2001)	√	√	√
Demographics	Questionnaire	√		

*Primary outcome measure

3.2.7.2.3 Dietary intake

Two methods were used to assess dietary intake. Parents firstly completed four multi-component questions which had been modified from a parent-reported questionnaire which has been validated in the preschool age group (The Eating and Physical Activity Questionnaire (EPAQ)) (Bennett, de Silva-Sanigorski, Nichols, Bell, & Swinburn, 2009). The second method was a 24-hour recall of the previous day's dietary intake. Parents entered this information into the 'Easy Diet Diary' app (Xyris Software (Australia) Pty Ltd) on an iPad. 'Easy Diet Diary' electronic files were then imported into 'FoodWorks 8 Professional' nutritional analysis software (Xyris Software (Australia) Pty Ltd) for analysis. Prior to the appointment parents were informed that they would be required to provide information on their child's intake for the previous day. If their child was in the care of someone else on this day (such as child care or a friend or relative), they were asked to obtain detailed information on their child's intake.

3.2.7.2.4 Child feeding

The questionnaire consisted of 12 questions from the validated Child Feeding Questionnaire (Birch et al., 2001) and asked parents about their attitudes, beliefs and practices regarding child feeding.

3.2.7.2.5 Screen-time

This questionnaire asked parents to estimate the usual amount of screen-time for their child on a typical weekday and weekend day to determine average screen-time per week. Questions were also included about the availability of screens and rules about screen entertainment. The questions are based on a questionnaire previously assessed for reliability (Downing, Hinkley, & Hesketh, 2015; Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012a).

3.2.7.2.6 Parental modelling

Parents were asked about parental modelling of the behaviors addressed in the intervention (nutrition, physical activity, screen-time and sleep). As there was not an appropriate validated tool in the existing literature, these four questions were developed after reviewing other parent-modelling questionnaires such as the Parental Modelling of Eating Behaviors Scale (Palfreyman, Haycraft, & Meyer, 2014) and the Home Environment Survey (Gattshall, Shoup, Marshall, Crane, & Estabrooks, 2008).

3.2.7.2.7 Parent self-efficacy

Parents were asked about their self-efficacy relating to their child's nutrition, physical activity, screen-time and sleep. This questionnaire consisted of 13 questions and was modified from a previously validated questionnaire (Bohman et al., 2013).

3.2.7.3 Demographic characteristics

Demographic information was collected from the parents via an iPad. Variables included participant child age, child sex, child date of birth, parent age, parent sex, parent height and weight, Aboriginal or Torres Strait Islander status, language spoken at home, postcode, where they found out about the study, child care/preschool attendance, number of children in household, number of adults in household, marital status, highest level of education, family income, relationship to child, birth weight, premature birth and duration of breastfeeding. This information was collected at baseline only.

3.2.7.4 Process evaluation

Process evaluation was undertaken via a questionnaire which participants were asked to complete at the end of the online program. Participants were asked to complete a series of questions with responses on a Likert scale. Specifically, participants were asked about program content, if the content was interesting, easy to understand, relevant and appropriate. They were asked about the length of the program and duration of the modules, the goal setting component, and feedback received from the dietitian. Participants were asked if they completed the modules in one sitting or at different times and how much time they spent to complete each module. They were asked about the online delivery of the program and if they would have preferred a different format. They were also asked about the Facebook component of the program.

3.2.8 Statistical analysis

The outcomes were assessed by comparing the differences in change over time between the intervention and comparison groups. Linear mixed were used to analyze the data to determine differences between groups over time (baseline, 3- and 6-months) with adjustment for potential covariates (see below).

Intention-to-treat principles were used, with all participants analyzed in the group which they were randomized. Covariates included age and cohort.

Two types of exploratory analyses were conducted to examine the theoretical assumptions of the intervention. First, hypothesized mediators of change in BMI (child physical activity, screen-time, eating behaviors, sleep, parent self-efficacy, parental role-modelling) were examined using the PROCESS SPSS Macro version 2.16.

Potential moderators of the intervention effects (e.g., child age and sex) were also explored using the PROCESS SPSS Macro version 2.16 (Hayes, 2015).

Differences in changes over time between high and low engagement in the Facebook component of the study were assessed for each outcome using linear mixed models. Baseline values and age were included as covariates and intention-to-treat principles were used for all normally distributed data.

All tests were conducted in IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA).

3.3 Discussion

This paper describes the *Time2bHealthy* study - the first RCT to the author's knowledge to assess the efficacy of an online parent-focused healthy lifestyle program for preschool-aged children in changing BMI. This study therefore fills a gap in the literature and addresses many limitations in similar studies conducted in older age groups, such as risk of bias, small sample size, lack of follow-up and parents not being the agents of change in most studies (Hammersley et al., 2016).

The study has a number of strengths. Objective and valid data collection methods were used for outcome measures. A 6-month follow-up determined if the changes made during the intervention could be maintained. The mode of delivery used for the study has demonstrated the potential to be effective. Multiple obesity-related behaviors including healthy eating, physical activity, screen-time and sleep were targeted in the intervention. Finally, the intervention was designed in line with Social Cognitive

Theory using an established backwards intervention mapping process.

There are however some limitations. The study design included children of a healthy weight and it is therefore possible that the BMI changes may be diluted. As the comparison group also received information on similar topics, it is possible that behavior change may have occurred in both groups. Due to the use of self-reported data for some measures, there was the potential for parents to intentionally or unintentionally misreport, however, this is an issue that is common to all free-living studies assessing behavioral measures such as dietary intake.

There was limited opportunity to establish rapport with participants (compared to face-to-face or telephone-based interventions). Initial rapport was established during the baseline face-to-face data collection appointment. A community was also established online through the closed Facebook group which facilitated communication and building rapport with and between participants.

This study makes an important contribution to the literature on Internet interventions for the prevention and/or treatment of childhood obesity where parents are the agents of change. Evidence indicates that carefully targeted Internet childhood obesity treatment and prevention programs have promising potential and the Internet is a mode of delivery which has been shown to offer specific appeal to the target group (Jones et al., 2009; Jones et al., 2011). A large proportion of Australian households are connected to the Internet (83% in 2012-2013), including those in regional, rural and remote areas (Australian Bureau of Statistics, 2014), potentially enabling widespread access to programs regardless of geographic location. The intervention also has the potential for broad reach as it negates many barriers associated with traditional delivery methods (Fitch et al., 2013; Grimes-Robison & Evans, 2008; Kelleher et al., 2017; Warren et al., 2007).

The *Time2bHealthy* study has potential for translation into primary health care services, in particular for parents in rural and remote areas, where access to obesity prevention and management services can be limited and overweight and obesity prevalence is higher (National Health and Medical Research Council of Australia, 2013b).

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Chapter 4

Time2bHealthy – an internet-based childhood obesity prevention program for parents of preschool-aged children: outcomes of a randomized controlled trial

This chapter presents the main outcomes of the *Time2bHealthy* RCT. The effect of *Time2bHeathy* on the primary outcome of child BMI and the secondary outcomes of child dietary intake, physical activity, screen-time and sleep and parent self-efficacy, parental modelling and child feeding are discussed. Process evaluation results are also presented.

This chapter has been submitted and is currently under review: Hammersley, M.L., Okely, A.D., Batterham, M.J., & Jones, R.A. *Time2bHealthy* – an internet-based childhood obesity prevention program for parents of preschool-aged children: outcomes of a randomized controlled trial. *Journal of Medical Internet Research* (under review).

4.1 Introduction

The WHO has described childhood obesity as one of the most significant public health issues (World Health Organization, 2017). Around 23% of children and adolescents in developed countries and 13% in developing countries are overweight or obese (Ng et al., 2014). One of the main influences on the development of childhood obesity is parental guidance and role-modelling around obesity-related behaviors, (Golley et al., 2011; Natale et al., 2014; Niemeier et al., 2012) particularly in the early years of life up to five years of age (Natale et al., 2014). Health behaviors become more difficult to change with age (Natale et al., 2014) and tend to track into adulthood (Luttikhuis et al., 2009), but are quite malleable in the early years (Natale et al., 2014). Therefore, early childhood is an opportune time to intervene and involving parents in interventions is crucial (Sung-Chan, Sung, Zhao, & Brownson, 2013).

Targeted interventions have the potential to alter the trajectory of childhood overweight and obesity continuing into adulthood and interventions which involve parents are the most successful (Grimes-Robison & Evans, 2008; Ho et al., 2012; Young et al., 2007). However, barriers to traditional face-to-face interventions such as scheduling of appointments (Grimes-Robison & Evans, 2008), stigma, parental denial (Kelleher et al., 2017), childcare for other siblings (Warren et al., 2007), travel (Fitch et al., 2013) and cost (Grimes-Robison & Evans, 2008) can prevent sustained parental involvement and commitment and therefore impact on the success of interventions.

Overweight and obesity interventions which use an eHealth delivery method offer many advantages compared to traditional delivery methods, particularly around convenience and accessibility. Most interventions using eHealth delivery methods have been conducted in older children and have not involved parents (Hammersley, Jones & Okely, 2016). In a recent meta-analysis of parent-focused eHealth obesity interventions for 0-18 year olds, around half of the included studies showed significant improvements to dietary intake or physical activity when compared to a control group, but there was no significant change in BMI/BMI *z*-score. In this review, no studies targeting children under the age of five years were included and it was recommended that larger, higher quality parent-focused eHealth studies be conducted, with a particular focus on younger age groups (Hammersley et al., 2016). There is also a lack of studies which focus on obesity-related behaviors beyond dietary intake and physical activity. It is important that interventions focus on total movement throughout the day and incorporate strategies to improve sleep and reduce sedentary behavior, aligning with the recommendations of recently released 24-hour movement guidelines (Australian Government Department of Health, 2017; Tremblay et al., 2017). Furthermore, although some studies have been underpinned by Social Cognitive Theory (Baranowski et al., 2003; Chen et al., 2011; Wright et al., 2013), few have assessed change in parent self-efficacy, a key construct of Social Cognitive Theory.

This paper reports the outcomes of a RCT evaluating the efficacy of a parent-focused internet-based program in facilitating behavior change in preschool-aged children who are overweight or at-risk of becoming overweight. It was hypothesized that children in the intervention group would achieve significantly greater reductions in BMI compared to the comparison group at 6-month follow-up. It was also hypothesized that the intervention group would achieve significantly greater improvements in child dietary intake, physical activity, screen-time, sleep, child feeding, and parent self-efficacy and role modelling.

4.2 Methods

4.2.1 Study design

The protocol for this study has been published (Hammersley, Jones, & Okely, 2017). Briefly, the *Time2bHealthy* study was based on formative research with parents of preschool-aged children (Jones et al., 2009) and was piloted (Jones, Price, Okely & Lockyer, 2011) prior to this trial. The current study was a two-arm parallel RCT involving parent-child dyads, recruited into six cohorts. The trial was conducted between January 2016 and December 2017 in the Illawarra, Southern and South-Western Sydney, Southern Highlands and Shoalhaven areas of New South Wales and Melbourne, Victoria, Australia. Measures were collected at baseline, 3-months post-baseline and 6-months post-baseline. The primary outcome was change in BMI 6-months post-baseline. The 6-month time-point was selected as it was not expected that the 3-month time-point would provide adequate time to detect changes in BMI. Secondary outcomes included child dietary intake, physical activity, screen-time, sleep, child-feeding practices and parent self-efficacy and role-modelling.

The Consolidated Standards of Reporting Trials (CONSORT) statement was used to guide the reporting of this study (Schulz, Altman & Moher, 2010). The study was registered with the Australian and New Zealand Clinical Trials Registry (12616000119493) and approved by the University of Wollongong Human Research Ethics Committee (HE15/354).

4.2.2 Participant recruitment and eligibility criteria

Potential participants were informed about the study through flyers distributed at early childhood education and care centers, general practices/primary health care centers, early childhood health centers, playgroups and local sporting groups. Flyers were also displayed on community noticeboards (e.g. libraries, shopping centers, children's activity centers) and articles were placed in the University of Wollongong and Local Health District newsletters and on Facebook. Media releases were also sent to local media outlets.

Participants were eligible if they had access to the Internet, if their child was 2-5 years of age (and not yet attending school) and was at or above the WHO 50th percentile for BMI for their age and sex (World Health Organization, 2006, 2007). Parents also needed to have a Facebook account or agreed to create one.

Child participants were excluded if they were taking medications or had a medical condition with the potential to affect weight or restrict age-appropriate play. Children with conditions which required the restriction of certain foods (e.g. Coeliac Disease or food allergies) were deemed eligible to participate, but parents were informed that parts of the program would not be completely appropriate and that they would need to make some adaptations to the material provided in order to match their child's individual dietary/health needs.

Informed written consent was provided by the parents/guardians after reading a participant information sheet. Provisional eligibility was determined through contact with participants via phone or email and was confirmed at the face-to-face baseline data collection visit when the child's height and weight were measured to confirm if the child's BMI was at or above the WHO 50th percentile for age and sex. Participants below the 50th percentile were excluded.

4.2.3 Randomization and blinding

Participants were randomized into the intervention or comparison group following the collection of baseline measures. Randomization was performed in a 1:1 ratio using a concealed computerized random number generator. A data manager with no other involvement in the study conducted the randomization. The researcher responsible for implementing the intervention was the only person who was informed about group allocation. At the follow-up data collection time-points, height and weight measurements were taken by trained data collectors blinded to group allocation.

4.2.3.1 *Time2bHealthy* intervention

Participants randomized to the intervention group were provided with an individual login to access the *Time2bHealthy* program. The development, content and theoretical framework for this intervention has been previously published (Hammersley et al., 2017). Briefly, the intervention was guided by Bandura's Social Cognitive Theory (Bandura, 1986) and was designed using a backwards intervention mapping process (Cornelius et al., 2014; Robinson & Borzekowski, 2006). The intervention targeted multiple behaviors and consisted of six modules including an introduction, nutrition (n=2), physical activity, screen-time and sleep which were completed by participants over an 11-week period. Each module comprised reading material, videos, activities, quizzes and a goal setting component. Participants received feedback on their goals at the end of each module by a dietitian and were provided with advice on how to improve their goals using the SMART goal framework (Locke & Latham, 2002). Participants also received weekly emails reminding them to log on to the website and participate in the activities. Participants were informed that they could make contact via email or phone if they had questions or concerns at any time. Participants in each of the cohorts were also encouraged to access and contribute to a closed (secret) Facebook group to communicate with other members of the cohort and the dietitian. There was a separate group for each cohort and they were regularly monitored and moderated by the dietitian. Participants were asked to post photos, recipes and personal experiences and ideas that they had found helpful for behavior change which were relevant to each module. If the dietitian could not answer a question raised, advice was sought from another member of the research team which included experts in physical activity. An incentive to post to the group was provided, with one post being selected from each module (Modules 2 through to 6) to receive a gift card.

Participants continued to receive emails fortnightly at the end of the program until the 6-month follow-up. Infographics summarizing the key points from each of the modules were provided in these emails and participants were also encouraged to log back into the website to revise the material and review their progress with their goals.

4.2.3.2 Comparison condition

Participants randomized to the comparison group received fortnightly emails which contained links to the *Raising Children Network* website (an Australian government-funded parenting website). The topics were similar to *Time2bHealthy* (nutrition, physical activity, screen-time and sleep) and also included other general health information. There were no interactive components available to this group. After the final data collection point at 6-months, participants from this group were provided access to *Time2bHealthy*, but they did not receive access to a Facebook group or to the regular emails.

4.2.4 Outcome measures

Measurements were taken at baseline, 3- and 6-months post-baseline. Participant measures were collected at the University of Wollongong, in the participant's home or in a community setting. Questionnaires were completed on an iPad by the parents during these 30-45 minute sessions. Demographic information was also collected from parents at the baseline data collection point. Participants in the intervention group were asked to complete a process evaluation questionnaire at the end of the online program, which assessed user acceptability of the program content, length, goal setting, Facebook discussion group and the modality used.

4.2.4.1 Primary outcome measure

Child height and weight were measured using a standardized method (National Health and Medical Research Council of Australia, 2013) to calculate BMI. A stadiometer was used to measure height to the nearest 0.1cm. Weight was measured (with no shoes and minimal clothing) to the nearest 0.1kg using a SECA scale. Both height and weight were measured twice. The mean of these two measurements was used to calculate BMI. A third measurement was taken when height measurements differed by more than 0.5cm and weight measurements differed by more than 0.5kg.

4.2.4.2 Secondary outcome measures

Dietary intake was assessed using both a parent-reported food questionnaire (modified from the Eating and Physical Activity Questionnaire (EPAQ) (Bennett et al., 2009) and a parent-reported 24-hour recall of child dietary intake (using the ‘Easy Diet Diary’ app (Xyris Software (Australia) Pty Ltd)). The section of the food questionnaire which asked about frequency of intake of discretionary foods was expanded to include additional discretionary food categories, which used the same scale as the existing question. The result of a Cronbach’s alpha test for these discretionary food questions was $\alpha=0.68$. Data from the 24-hour recall was used to calculate kJ per kg of body weight, percentage of kJ from sugar and percentage of kJ from saturated fat. Data from the food questionnaire were used to assess daily fruit intake, daily vegetable intake and frequency of fruit juice and sugary drinks intake. A discretionary food score was calculated based on responses to questions on frequency of intake of takeaway or fast food, sugary cereals, potato chips or other salty snacks, sweets, cakes, doughnuts and sweet cookies or muffins.

Physical activity intensity and duration was measured using an ActiGraph GT3X+ accelerometer (ActiGraph Corporation, Pensacola, FL) which was worn on an elasticized belt around the child’s waist for seven days. Accelerometer data were analyzed in ActiLife version 6 (ActiGraph Corporation, Pensacola, FL). A sampling frequency of 30 Hz was used, with the files then reintegrated into 15 s epochs. Non-wear time was defined as 20 minutes or more of 0 counts. Accelerometer data used for the physical activity analysis were considered valid based on wear time of at least six hours per day on three days, which has been found to be reliable in previous research

(Bingham et al., 2016). The following cut-points appropriate for preschool-aged children were used to categorize physical activity intensity; sedentary <100 counts/min, low light-intensity physical activity 101-800 counts/min, high light-intensity physical activity 801-1679 counts/min, moderate-intensity physical activity 1680-3367 count/min and vigorous-intensity physical activity ≥3368 count/min (Pate et al., 2006).

Sleep habits (sleep latency, sleep reluctance, difficulty sleeping and falling to sleep in own bed) were assessed based on four questions from the Children's Sleep Habits Questionnaire (Sneddon et al., 2013), questions about the child's usual sleep and wake times and an Actigraph GT3X+ accelerometer. The result of a Cronbach's alpha test for the three scaled questions relating to sleep reluctance, difficulty falling asleep and falling to sleep in own bed was $\alpha=0.63$. Sleep accelerometer data were analyzed in ActiLife using the Sadeh algorithm, which is appropriate for use in children (Sadeh, Sharkey, & Carskadon, 1994). Sleep accelerometer data were considered valid based on wear time of at least three nights (Bagley & El-Sheikh, 2013).

Parent-reported questionnaires were used to assess child feeding (from the Child Feeding Questionnaire pre-defined subscales of 'restriction' and 'pressure to eat' (Birch et al., 2001)), screen-time (based on Downing et al (2015) and Hinkley et al (2012) and additional questions relating to screen entertainment rules, presence of a TV in the child's bedroom and frequency of watching TV while eating a meal), parent modelling (developed after reviewing Gattshall et al (2008) and Palfreyman et al (2014)), and parent self-efficacy in nutrition, physical activity, screen-time and sleep (modified from Bohman et al (2013) by adding six additional questions and making small changes to some existing questions to align the questionnaire to the program content). Cronbach's alpha tests were conducted on the parent modelling and parent self-efficacy and were α=0.63 and α=0.89 respectively.

4.2.5 Power and sample size

Based on the results of the pilot study (Jones,Wells, Okely, Lockyer & Walton, 2011), we expected a BMI effect size of approximately 0.4 for this trial. To detect a statistically significant difference between groups (α=0.05 and power=0.8), 136 participants were required (68 per group) and based on an estimated attrition rate of 15%, we aimed to recruit 160 participants (80 per group).

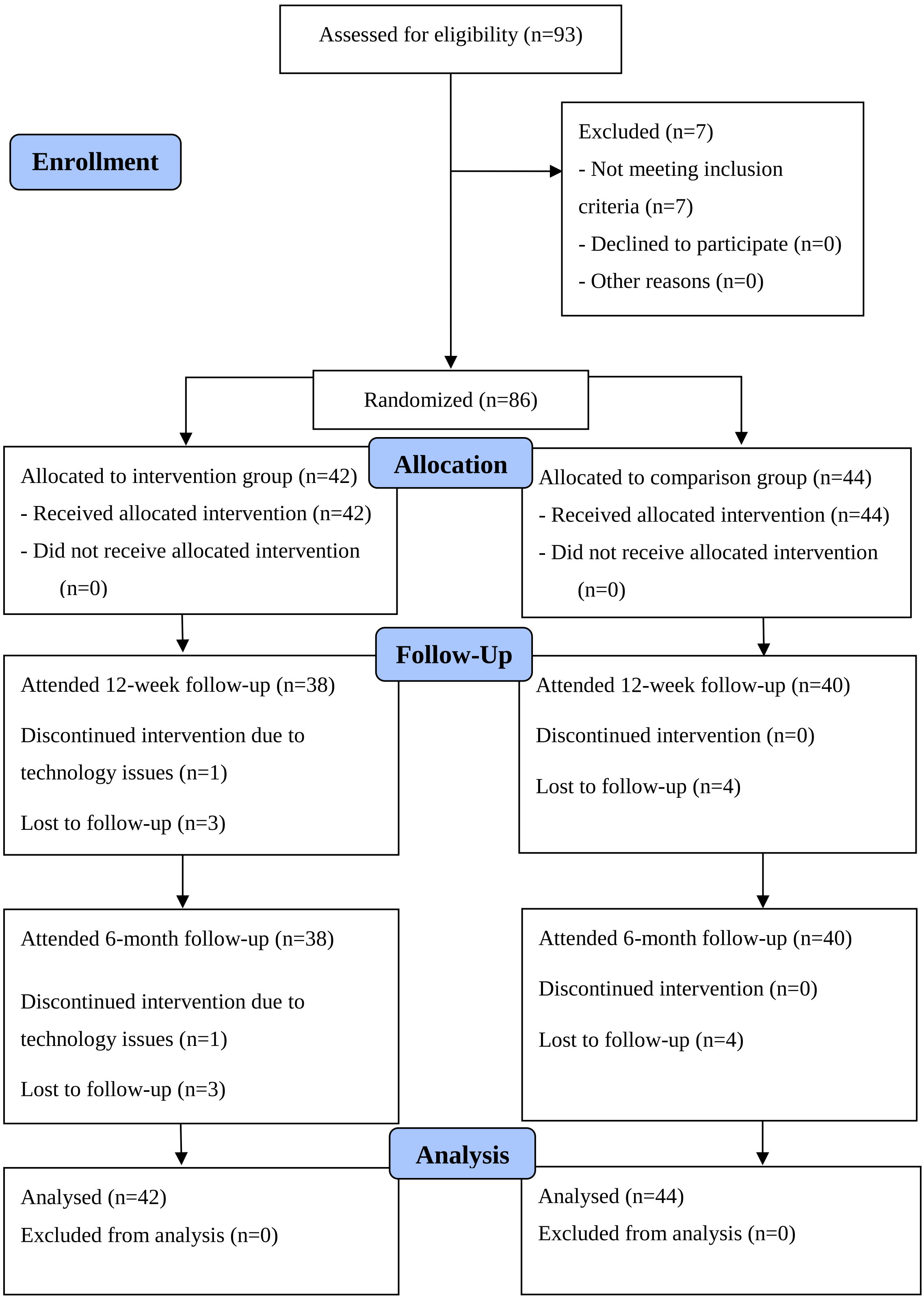
4.2.6 Statistical analyses

Differences in changes over time between the intervention and comparison groups were assessed for each outcome. Linear mixed models were used to determine differences between groups over time (baseline, 3-months and 6-months) with adjustment for potential covariates. Intention-to-treat principles were used for parametric data, with all participants analyzed in the group which they were randomized regardless of whether they attended all data collection time-points or completed the intervention. Covariates included baseline values, age and cohort. In addition to the intention-to-treat analysis, a completers analysis was conducted using linear mixed models, which included intervention participants who had completed at least five modules (>80% of online content) and comparison participants who attended all data collection time-points. Due to non-parametric distributions for some variables, Freidman's tests and Wilcoxon Signed Rank tests were used followed by Mann Whitney tests to analyze non-parametric data using completed cases. Generalized estimating equations were considered, however the analyses would not converge and it was therefore not possible to obtain a result from these analyses. Analyses were performed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA).

4.3 Results

Figure 4.1 shows the flow of participants through the study. Recruitment was conducted between January 2016 and June 2017. Enquiries were received from 372 parents initially. After viewing the information sheet, 159 parents remained interested in the study and were screened via phone or email, with 104 being potentially eligible. Of the 93 parent/child dyads who attended the initial visit, 86 were eligible and enrolled in the study. Forty-two participant dyads were randomized to the intervention group and 44 to the comparison group. Follow-up was conducted between July 2016 and December 2017. Seventy-eight participants (91%) attended the 3- and 6-month follow-ups, with seven (8%) lost to follow-up and one participant (1%) withdrawing from the intervention group due to problems accessing the Internet. **Figure 4.2** shows the completion of each of the intervention program modules. At least five of six modules were completed by 29 participants (69%).

Figure 4.1: CONSORT flow diagram for the *Time2bHealthy* study



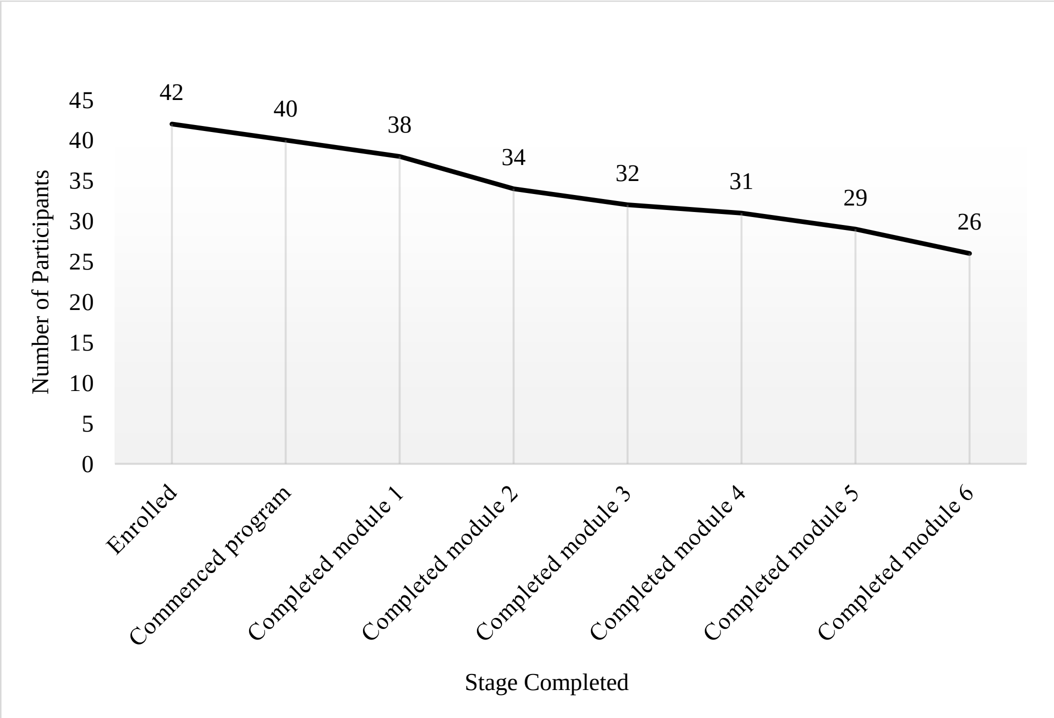


Figure 4.2: Participant completion of *Time2bHealthy* modules

4.3.1 Participant characteristics

Baseline characteristics of participants are displayed in **Table 4.1**. The mean child (SD) age was 3.46 (0.92) years and 50% of child participants were female. The mean (SD) participating parent age was 35.17 (4.80) years and 97% were female, 63% had a university degree, 50% had an after-tax income of at least $580/week and 85% were married or had a partner. The majority of children were in the healthy weight range (91%) according to WHO criteria (World Health Organization, 2017). The mean (SD) child BMI was 17.01 (1.24). The mean (SD) participating parent BMI was 26.08 (5.97) and 45% of parents were overweight or obese.

Table 4.1: Baseline characteristics of *Time2bHealthy* participants

	Intervention Group (n=42)	Comparison Group (n=44)	All (n=86)
Child sex			
Boy (%)	24 (57)	19 (43)	43 (50)
Girl (%)	18 (43)	25 (57)	43 (50)
Mean child age (months) (SD)	40 (9.65)	43 (12.26)	42 (11.05)
Mean child age (years) (SD)	3.36 (0.80)	3.55 (1.02)	3.46 (0.92)
Mean child BMI (SD)	17.28 (1.44)	16.72 (0.92)	17.01 (1.24)
Child weight status[a]			
Healthy Weight (%)	40 (95)	38 (86)	78 (91)
Overweight (%)	2 (5)	5 (11)	7 (8)
Obese (%)	0 (0)	1 (2)	1 (1)
Child Aboriginal/Torres Strait Islander status			
Aboriginal (%)	1 (2)	4 (9)	5 (6)
Torres Strait Islander (%)	0 (0)	0 (0)	0 (0)
No (%)	40 (95)	39 (89)	79 (92)
Not answered (%)	1 (2)	1 (2)	2 (2)
Participating parent sex			
Male (%)	2 (5)	1 (2)	3 (3)
Female (%)	40 (95)	43 (98)	83 (97)
Mean age participating parent (SD)	35.45 (4.95)	34.91 (4.68)	35.17 (4.80)
Highest level of education of participating parent			
Not university qualified (%)	8 (19)	22 (50)	30 (35)
University qualified (%)	32 (76)	22 (50)	54 (63)
Currently studying (%)	2 (5)	0 (0)	2 (2)
Participating parent income after tax			
<$580/week (%)	20 (48)	23 (52)	43 (50)
$580-$1240/week (%)	16 (38)	15 (34)	31 (36)
>$1240/week (%)	6 (14)	6 (14)	12 (14)
Mean BMI participating parent (SD)	24.81 (4.64)	27.38 (21.61)	26.08 (5.97)
Weight status participating parent			
Underweight (%)	1 (2)	1 (2)	2 (2)
Healthy Weight (%)	26 (62)	15 (34)	42 (49)
Overweight (%)	9 (21)	13 (30)	22 (26)
Obese (%)	6 (14)	11 (25)	17 (20)
Not answered	0 (0)	3 (7)	3 (3)
Aboriginal status of participating parent			
Aboriginal (%)	1 (2.38)	2 (4.55)	3 (3.49)
No (%)	40 (95.24)	41 (88.64)	81 (94.19)
Not answered (%)	1 (2.38)	1 (2.27)	2 (2.33)
Participating parent relationship with child			
Biological mother (%)	39 (93)	41 (93)	80 (93)
Biological father (%)	2 (5)	2 (5)	4 (5)
Other (%)	1 (2)	1 (2)	2 (2)

	Intervention Group (n=42)	Comparison Group (n=44)	All (n=86)
Marital status participating parent			
Single/divorced/separated/widowed (%)	3 (7)	10 (23)	13 (15)
Married/with partner (%)	39 (93)	34 (77)	73 (85)
Mean BMI other parent (SD)	28.24 (6.72)	27.61 (4.51)	27.95 (5.76)
Weight status other parent			
Underweight (%)	0 (0)	0 (0)	0 (0)
Healthy weight (%)	15 (36)	9 (20)	24 (28)
Overweight (%)	9 (21)	13 (30)	22 (26)
Obese (%)	11 (26)	9 (20)	20 (23)
Not answered / N/A (%)	7 (17)	13 (30)	19 (22)
Income other parent			
<$580/week (%)	5 (12)	6 (14)	11 (13)
$580-$1240/week (%)	19 (45)	20 (45)	39 (45)
>$1240/week (%)	15 (36)	9 (20)	24 (28)
Not answered / N/A	3 (7)	9 (20)	12 (14)
Language spoken at home			
English (%)	37 (88)	40 (91)	77 (90)
Other (%)	5 (12)	4 (9)	9 (10)
Found out about the program			
Early childhood education center (%)	16 (38)	18 (41)	34 (40)
Flyer (%)	7 (17)	5 (11)	12 (14)
Early childhood nurse/center (%)	5 (12)	2 (5)	7 (8)
Email (%)	4 (10)	0 (0)	4 (5)
School newsletter (%)	1 (2)	2 (5)	3 (3)
Media (print, TV, radio) (%)	1 (2)	2 (5)	3 (3)
Social media (%)	4 (10)	5 (11)	9 (10)
Playgroup (%)	0 (0)	3 (7)	3 (3)
Other (%)	4 (10)	7 (16)	11 (13)

[a] WHO definition (World Health Organization, 2017)
% = percent, BMI – Body Mass Index, TV – television, SD – Standard Deviation

4.3.2 Primary outcome

Table 4.2 displays the baseline, 3-month and 6-month BMI results. The results of the intention-to-treat, displayed in **Table 4.3** and the completer's analyses indicated that there was no group by time effect for BMI.

4.3.3 Secondary outcomes

Table 4.2 displays the baseline, 3-month and 6-month results for normally distributed secondary outcomes. The linear mixed model analyses (displayed in **Table 4.3**) found a significant group by time interaction for frequency of consumption of discretionary foods (estimate -1.360, 95% CI -2.272 to -0.447, *P*=0.00), parent self-efficacy (nutrition) (estimate 0.429, 95% CI 0.096 to 0.763, *P*=0.01) and child feeding – pressure to eat (estimate -0.304, 95% CI 0.605 to -0.003, *P*=0.048). No group by time interaction effect for any other secondary outcomes were observed. The linear mixed model completer's analyses of the parametric data were similar to the intention-to-treat results with the exception of a significant group by time interaction for number of fruit serves (estimate -0.372, 95% CI -0.735 to -0.008, *P*=0.05) and parent modelling (estimate 0.288, 95% CI 0.030 to 0.546, *P*=0.03).

Table 4.2: Mean values (and SD) for *Time2bHealthy* RCT primary and secondary outcomes at each time-point

Variable	Baseline		3-months		6-months	
	Comparison	**Intervention**	**Comparison**	**Intervention**	**Comparison**	**Intervention**
BMI	17.280 (1.438)	16.724 (0.915)	16.987 (1.248)	16.463 (0.804)	16.870 (1.238)	16.508 (0.753)
kJ/kg of body weight [a]	330.429 (125.084)	343.635 (112.007)	296.24 (114.638)	303.750 (120.145)	296.20 (82.048)	327.600 (104.064)
Percentage of kJ from sugar[a]	22.235 (6.750)	20.139 (7.013)	21.147 (7.303)	20.832 (6.015)	19.286 (7.008)	19.545 (6.954)
Percentage of kJ from saturated fat[a]	12.522 (4.771)	11.738 (3.951)	11.575 (3.836)	11.368 (3.907)	12.500 (3.742)	11.000 (3.902)
Serves of fruit[b]	2.910 (1.030)	2.524 (0.917)	2.950 (0.959)	2.474 (0.830)	2.875 (1.042)	2.526 (0.862)
Serves of vegetables[b]	2.341 (1.077)	2.619 (1.268)	2.525 (1.219)	2.842 (1.220)	2.650 (1.051)	2.974 (1.284)
Discretionary food frequency score[c]	11.727 (2.856)	11.214 (3.816)	11.600 (2.725)	9.816 (3.212)	11.900 (2.285)	10.395 (3.218)
Self-efficacy (nutrition)[d]	7.943 (1.131)	8.194 (1.362)	8.283 (1.194)	8.693 (0.968)	8.300 (1.216)	8.886 (0.886)
Child feeding – Restriction[e]	3.603 (0.918)	3.631 (0.776)	3.728 (0.836)	3.694 (0.749)	3.578 (0.891)	3.661 (0.792)
Child feeding – Pressure[e]	2.341 (0.981)	2.520 (0.994)	2.344 (1.087)	2.171 (1.078)	2.425 (1.043)	2.138 (0.991)
Parent modelling[f]	3.949 (0.758)	3.976 (0.792)	3.933 (0.848)	4.184 (0.552)	4.156 (0.733)	4.355 (0.535)

Variable	**Baseline**		**3-months**		**6-months**	
	Comparison	**Intervention**	**Comparison**	**Intervention**	**Comparison**	**Intervention**
Sleep duration (hrs)[g]	9.587 (0.933)	9.846 (0.778)	9.737 (0.724)	9.908 (0.623)	9.783 (0.959)	9.536 (0.639)
Sleep latency (min)[g]	19.916 (16.554)	20.975 (14.412)	19.968 (18.053)	16.442 (11.905)	22.187 (11.846)	25.003 (18.028)
Sleep reluctance[h]	3.000 (1.239)	2.357 (1.055)	2.650 (1.001)	2.132 (0.991)	2.675 (0.971)	2.243 (1.140)
Screen-time – Week day (hrs)[i]	2.519 (2.548)	2.817 (3.868)	1.372 (1.062)	1.726 (2.469)	2.204 (2.907)	1.259 (0.991)
Screen-time – Weekend day (hrs)[i]	2.939 (1.979)	3.147 (2.946)	2.309 (1.559)	1.840 (1.434)	2.679 (2.329)	2.037 (1.386)
Percentage sedentary[g]	46.276 (7.980)	47.441 (11.093)	48.280 (7.865)	49.167 (4.033)	46.450 (6.214)	49.466 (5.561)
Percentage LMVPA[g]	27.739 (7.399)	25.817 (6.238)	26.179 (6.163)	25.613 (4.377)	27.732 (5.421)	25.435 (4.933)
Percentage MVPA[g]	13.881 (5.037)	12.019 (3.596)	13.564 (4.430)	12.911 (3.704)	14.378 (4.113)	13.010 (3.767)

[a]Calculated from 24-hour diet recall using Easy Diet Diary/Foodworks; [b] From Food Questionnaire, [c] Scored from food questionnaire questions on frequency of intake of takeaway or fast food; sugary cereals; potato chips or other salty foods; sweets; and cakes doughnuts, sweet cookies or muffins. Responses of never or rarely; 1-3 times per month; 1-2 times per week; 3-4 times per week; 5-6 times per week; once per day; and 2 or more times per day were coded as 1-6 respectively and summed to obtain a discretionary food score; [d] Self-efficacy questionnaire; [e] Child feeding questionnaire; [f] Parent-modelling questionnaire; [g] Accelerometer-measures; [h] From sleep questionnaire; [i] From screen-time questionnaire. BMI – Body Mass Index, kJ – kiloJoules, SD – Standard Deviation, hrs – hours, min – minutes, LMVPA – light-, moderate- to vigorous-intensity physical activity, MVPA – moderate- to vigorous-intensity physical activity.

Table 4.3: Results of intention-to-treat analyses for primary and secondary outcomes of the *Time2bHealthy* RCT

Variable	Estimate*	95% Confidence Interval		*P*-value*
		Lower Bound	Upper Bound	
BMI	-0.108	-0.337	0.1205	0.35
kJ/kg of body weight[a]	10.893	-29.942	51.728	0.60
Percentage of kJ from sugar[a]	-0.093	-2.441	2.254	0.94
Percentage of kJ from saturated fat[a]	-0.609	-3.092	1.873	0.63
Serves of fruit[b]	-0.240	-0.583	0.104	0.17
Serves of vegetables[b]	0.172	-0.153	0.494	0.24
Discretionary food frequency score[c]	-1.340	-2.272	-0.447	0.00
Self-efficacy (nutrition)[d]	0.429	0.096	0.763	0.01
Child feeding – Restriction[e]	0.038	-0.209	0.286	0.76
Child feeding – Pressure[e]	-0.304	-0.605	-0.003	0.048

Variable	Estimate*	95% Confidence Interval		*P*-value*
		Lower Bound	Upper Bound	
Parent modelling[f]	0.210	-0.023	0.442	0.08
Sleep duration (hrs)[g]	-0.222	-0.571	0.128	0.21
Sleep latency (min)[g]	-0.248	-0.789	0.739	0.95
Sleep reluctance[h]	-0.355	-0.767	0.057	0.09
Screen-time – Week day (hrs)[i]	-0.199	-0.867	0.469	0.56
Screen-time – Weekend day (hrs)[i]	-0.400	-0.895	0.097	0.11
Percentage sedentary[g]	0.838	-1.597	-3.272	0.49
Percentage LMVPA[g]	-0.989	-2.204	2.006	0.93
Percentage MVPA[g]	0.536	-0.938	2.010	0.47

***** n=86 - Linear mixed model (random intercept, compound symmetry covariance structure) adjusted 6-month difference. Age, cohort and baseline values included as covariates in the model. Significant at $P<0.05$; [a]Calculated from 24-hour diet recall using Easy Diet Diary/Foodworks; [b]From Food Questionnaire, [c]Scored from food questionnaire questions on frequency of intake of takeaway or fast food; sugary cereals; potato chips or other salty foods; sweets; and cakes doughnuts, sweet cookies or muffins. Responses of never or rarely; 1-3 times per month; 1-2 times per week; 3-4 times per week; 5-6 times per week; once per day; and 2 or more times per day were coded as 1-6 respectively and summed to obtain a discretionary food score; [d]Self-efficacy questionnaire; [e]Child feeding questionnaire; [f]Parent-modelling questionnaire; [g]Accelerometer-measures; [h]From sleep questionnaire; [i]From screen-time questionnaire. The actual number of observations at baseline varied from 34 to 44 in the comparison group and 34 to 42 in the intervention group. **The number of observations at 3-months varied from 19 to 40 in the comparison group and from 28 to 38 in the intervention group. The number of observations at 6-months varied from 20 to 40 in the comparison group and from 21 to 38 in the intervention group. BMI – Body Mass Index, kJ – kiloJoules, hrs – hours, min – minutes, LMVPA – light-, moderate- to vigorous-intensity physical activity, MVPA – moderate- to vigorous-intensity physical activity.

The results of the Mann Whitney tests for the non-parametric data showed that there were no significant differences between groups for any parameter (at Bonferroni adjusted $p<0.008$).

4.3.4 Process evaluation

Thirty-seven participants from the intervention group (88%) completed the process evaluation questionnaire. The results are displayed in **Table 4.4**. Most participants agreed or strongly agreed that the program content was interesting (95%), easy to understand (100%) and relevant (97%). Most also agreed or strongly agreed that the length of the program was appropriate (87%), the goal setting component was helpful (79%) and that the dietitian was helpful and knowledgeable (92%). Most participants discussed the program with extended family members (74%). The Internet-based delivery mode of the program was suitable for the majority of participants (97%), however six participants stated that they would have preferred a different mode of delivery such as a mobile-optimized website (n=2), smartphone app (n=2), face-to-face (n=2) or hard copy (n=2). Only 15 participants (41%) agreed or strongly agreed that the Facebook component was useful.

Table 4.4: *Time2bHealthy* intervention process evaluation (n=38)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
The program content was interesting	21 (55%)	15 (39%)	2 (5%)	0	0	0
The program content was easy to understand	28 (74%)	10 (26%)	0	0	0	0
The program content was relevant	22 (58%)	15 (39%)	1 (3%)	0	0	0
The length of the program was appropriate	15 (39%)	18 (47%)	2 (5%)	3 (8%)	0	0
One module every 2 weeks was appropriate	11 (29%)	23 (61%)	4 (11%)	0	0	0
The tips and tricks for parents was helpful	20 (53%)	17 (45%)	1 (3%)	0	0	0
The information about meals was helpful	22 (58%)	13 (34%)	2 (5%)	1 (3%)	0	0
There was enough information in the module about meals	14 (37%)	20 (53%)	0	4 (11%)	0	0
The information on snacks and drinks was helpful	21 (55%)	15 (39%)	1 (3%)	1 (3%)	0	0
There was enough information in the module	15 (39%)	19 (50%)	2 (5%)	2 (5%)	0	0

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**N/A**
about snacks and drinks						
The information about physical activity was helpful	20 (53%)	16 (42%)	2 (5%)	0	0	0
There was enough information in the module about physical activity	19 (50%)	17 (45%)	2 (5%)	0	0	0
The information on screen-time was helpful	20 (53%)	13 (34%)	4 (11%)	1 (3%)	0	0
There was enough information in the module about screen-time	14 (37%)	20 (53%)	4 (11%)	0	0	0
The information about sleep was helpful	11 (29%)	19 (50%)	6 (16%)	0	1 (3%)	1 (3%)
There was enough information about sleep	8 (21%)	24 (63%)	4 (11%)	0	1 (3%)	1 (3%)
The goal setting was helpful	12 (32%)	18 (47%)	7 (18%)	1 (3%)	0	0
The number of goals set was appropriate	12 (32%)	18 (47%)	7 (18%)	0	1 (3%)	0
The health consultants were helpful and knowledgeable	20 (53%)	15 (39%)	1 (3%)	1 (3%)	0	1 (3%)
The time the health consultants responded in was appropriate	21 (55%)	16 (42%)	0	0	0	1 (3%)
The online delivery mode	19 (50%)	18 (47%)	1 (3%)	0	0	0

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**N/A**
was suitable						
The Facebook group component was useful	3 (8%)	12 (32%)	18 (47%)	4 (11%)	1 (3%)	0
	Yes	**No**	**Don't Know**			
Did you talk about the program with extended family members (e.g. grandparents) or carers	28 (74%)	10 (26%)				
I would have preferred a different mode of delivery	6 (16%)	28 (74%)	Don't know 4 (11%)			
If yes, specify which	Mobile-optimized website (2), Smartphone app (2), Face-to-face (2), Hard copy (2)					

4.4 Discussion

In this RCT, no significant difference was found in BMI change between the two groups at 6-months post-baseline. There were no significant differences in physical activity, screen-time or sleep outcomes between groups. The intervention did, however, show some positive results in relation to dietary intake, child feeding and parent self-efficacy (nutrition). To the best of the author's knowledge, *Time2bHealthy* is the first RCT to assess the efficacy of a parent-focused healthy lifestyle intervention on BMI in preschool-aged children which is delivered entirely online.

The null finding regarding BMI change at 6-months aligns with similar eHealth obesity prevention studies conducted in young (Wald, Ewing, Moyer & Eickhoff, 2018) and older children (Baranowski et al., 2003; Chen et al., 2011; Paineau et al., 2008) and a recent mHealth study in preschool-aged children that measured fat mass index (Nystrom et al., 2017). Due to a lack of eHealth studies in this age group, the findings were also compared with studies delivered by more traditional methods. Mixed results have been reported from traditionally delivered parent-focused obesity prevention studies in young children, with a recent meta-analysis finding a short-term, but not long-term effect (Yavuz, van Ijzendoorn, Mesman & van der Veek, 2015). This meta-analysis also found that interventions targeting only overweight and obese children were more effective than those that included children in the healthy weight range (Yavuz et al., 2015). Given that >90% of children recruited to the study were in the healthy weight range, significant changes may have been unrealistic. Superior outcomes may have been achieved had the study included only overweight and obese children. Children at-risk of overweight and obesity were included in this study as prevention is key to impacting on childhood obesity rates and it is critical to design interventions that facilitate establishment of healthy behaviors and maintenance of healthy weight in all children at an early age (Gruber & Haldeman, 2009). Had the target sample size been achieved, it is possible that a difference between groups would have been found.

Other eHealth parent-focused studies have demonstrated similar improvements in dietary outcomes, such as energy dense food consumption (Harvey-Berino & Rourke, 2003; Louzada, Campagnolo, Rauber, & Vitolo, 2012). The discretionary food results in the current study most closely align with Williamson et al’s (2006) Internet-based study targeting adolescent overweight girls which demonstrated reduction in 'eating fattening foods’. Contrary to the current study, previous eHealth studies have also shown improvements in fruit and vegetable intake, including Chen et al’s Internet-based study on adolescents (Chen et al., 2011) and Knowlden and Conrad’s Internet-based study for mothers of 4-6 year old children (Knowlden & Conrad, 2018). Reduction in sugar sweetened beverage intake was also reported in an Internet-based parent-focused study for children aged 18-24 months (van Grieken et al., 2017). Some traditionally-delivered parent-focused interventions in preschool-aged children have also demonstrated improvements in fruit and vegetable consumption (Haire-Joshu et al., 2008) and reductions mean energy intake (Shelton et al., 2007).

The null findings in regard to kJ/kg body weight and kJ from sugar and saturated fat were perhaps due to the fact that the 24-hour recall was administered (due to resource constraints) on one single weekday at each time-point and thus regular and weekend consumption patterns were not captured. It is also possible that the intervention effects on each of the obesity-related behaviors could have been diluted due to the multi-behavior focus and breadth of content covered compared to previous studies which have focused on fewer behaviors.

Similar eHealth parent-focused studies in a range of age groups have shown mixed physical activity outcomes (Chen et al., 2011; Davis, Sampilo, Gallagher, Landrum & Malone, 2013; Haerens et al., 2006; Nystrom et al., 2017; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006). One successful Internet-based study of adolescents used pedometers to self-monitor activity (Chen et al., 2011), which may have enhanced motivation. Few traditionally delivered parent-focused studies have demonstrated an improvement in physical activity (Skouteris et al., 2011). Accelerometry compliance was not optimal in this study (n=69 at baseline, n=58 at 3-months and n=53 at 6-months) and therefore the results may not be indicative the whole sample. Night-time accelerometry compliance was even lower (n=68 at baseline, n=47 at 3-months and n=41 at 6-months). To the best of the author's knowledge, no similar eHealth studies have assessed sleep outcomes, however a traditionally delivered program found a significant increase in parent-reported sleep duration (Haines et al., 2013). Further studies are needed which objectively measure sleep duration and explore strategies to improve night-time accelerometry compliance, such as the use of wrist-worn monitors (Fairclough et al., 2016), incentives or phone calls/email reminders (Tudor-Locke et al., 2015). Screen-time behavior has also not been a focus of many parent-focused childhood obesity studies. One eHealth study in young children (Wald et al., 2018) and two in older children found null screen-time outcomes (Paineau et al., 2008; Wright et al., 2013), which align with these findings. Knowlden et al (2018), found improvements in both groups and an improvement in parent self-efficacy (screen-time) in the intervention group, so perhaps a minimal intervention can effect change in this area.

The limited success of *Time2bHealthy* and other eHealth childhood obesity interventions in improving BMI and obesity-related behaviors (outlined in Chapter 2) also extends to traditionally-delivered programs targeting preschool-aged children, which have had limited long-term success and are generally more successful in studies targeting overweight and obese children (Yavuz et al., 2015). Typically, eHealth interventions have been more successful in producing outcomes in subjectively measured dietary intake measures such as energy intake (Harvey-Berino & Rourke, 2003; Louzada et al., 2012, Haire-Joshu et al., 2008; Shelton et al., 2007), fat intake (Williamson et al., 2006), and fruit and vegetable intake (Chen et al., 2011; Knowlden & Conrad, 2018, Haire-Joshu et al., 2008; Shelton et al., 2007) than objective measures such as weight status and accelerometer-measured physical activity, with the exception of Chen et al (2011), who found improvements in waist-to-hip ratio and accelerometer-measured physical activity. Therefore, it could be disputed that social desirability bias may weigh into these results (Bornhorst, Huybrechts, Ahrens and Eiben, 2013; Gemming, Jiang, Swinburn, Utter, & Mhurchu, 2014). However, other self/proxy-reported measures such as screen-time and questionnaire-measured physical activity have showed null results. Furthermore, this bias would have occurred in both groups, so would probably not explain significant differences found between groups. Alternatively, it is possible that child dietary intake may be more amenable to intervention that other obesity-related variables.

Research clearly demonstrates the need to intervene early to establish healthy behaviors (Campbell & Hesketh, 2007) and the role of parents at this stage is instrumental to achieving change (Gruber & Haldeman, 2009; Niemeier et al., 2012; Sung-Chan et al., 2013; Ventura & Birch, 2008). The results of this RCT suggest that an Internet-based program can be effective in facilitating change, particularly for dietary-related behaviors. The positive dietary-related outcomes may be a reflection of a higher proportion of the program being focused on healthy eating and the activities in these modules being more intensive and involving more practical application. The dietary-related modules were also completed first, with 32 (76.19%) participants completing these two modules. Participation (and perhaps motivation) dropped off as participants worked through the modules, with 26 participants (61.90%) completing all six modules.

A cost-effectiveness analysis was not within the scope of this study. While it is generally perceived that that eHealth interventions are more cost-effective than traditionally-delivered programs, more research is needed (Jelalian, Rancourt, & Sato, 2013). The weight status range of children in this sample demonstrates that the intervention can be applied to both healthy weight and overweight/obese children.

Recruitment for this study was challenging, despite the expansion of the recruitment area and extension of the recruitment period, and we are not able to determine with certainty the factors involved in the lower than anticipated sample size without further investigation. Further work is required to explore optimal avenues to access at-risk and hard to reach populations. Parental awareness of their child’s weight status may have been a factor in the low enrolment rates. Previous research has found that the majority of parents do not recognize that their child is overweight (Lundahl, Kidwell & Nelson 2014) and therefore parents may not have recognized the need for the program. Education and monitoring initiatives may therefore be useful to enhance parent awareness. Feedback from participants who initially enquired about the study indicated that the need to attend face-to-face appointments for data collection was a deterrent. As the intervention is solely internet-based, it could be easily translated to a real-world setting given that most developed countries (Australian Bureau of Statistics, 2018; Pew Research Center, 2018; Office for National Statistics, 2018) have a high proportion of internet users. In a real-world setting, data could be collected online which could improve participant recruitment and retention, but lack of objectively measured data may create bias issues. The requirement for participants to have a Facebook account may also have been a factor if potential participants did not have an interest in engaging with social media or felt uncomfortable sharing information online with people they did not know. It is recommended that further studies with a longer follow-up period and those which translate programs into primary health care be conducted to demonstrate long-term effectiveness.

4.4.1 Strengths and limitations

This study used a randomized controlled design, applying a backwards intervention mapping exercise to align the intervention with Social Cognitive Theory (Cornelius et al., 2014; Robinson & Borzekowski, 2006). Multiple health behaviors were targeted, and outcome measures were based on objective and valid methods where possible. There was a low attrition rate and the mode of delivery, content and format of the program demonstrated a high rate of user acceptability.

There are several limitations of this study. While it was intentional to include children of a healthy weight in this study, there were a higher than anticipated proportion of children (over 90%) in the healthy weight range. Therefore, the effect on BMI may have been diluted. Due to the small number of children in the overweight and obese ranges, it was not possible to conduct a sub-analysis of these participants. Statistical power would have been affected by the fact that the target sample size was not achieved despite measures to enhance participant recruitment, including expanding the recruitment area and extending the recruitment period. It is also possible that a longer follow-up period may have been required to demonstrate differences in BMI change between groups. As there were multiple outcomes assessed, there is a risk that there may have been a Type 1 error. Questionnaire-based measures and the 24-hour recall used for secondary outcomes involved proxy-reporting of data and therefore it may have been possible that parents misreported this information (either intentionally or unintentionally) and would probably have occurred in both groups. This is a familiar challenge to researchers assessing behavioral outcomes (Gemming et al., 2014; Poslusna, Ruprich, de Vries, Jakubikova, & van't Veer, 2009). A height measure could not be obtained at the data collection appointment for two participants. Parent-provided measures were used in these instances.

The 24-hour recall was self-administered by parents on one single weekday (due to resource constraints) at each time-point and thus regular and weekend consumption patterns were not captured. In some cases, parents were also required to report on their child's dietary intake on a day their child was not in their care and although parents were asked to obtain detailed dietary intake information from the child's carer for this day, the accuracy of this information may not have been optimal. A systematic review of dietary assessment methods for children determined the most accurate method to be interviewer-administered parent proxy-reported 24-h recall over a 3-day period (Burrows, Martin, & Collins, 2010). While there has been limited research yet on the accuracy of self-administered parent proxy-reported electronic 24-h recall methods, and no validation studies on proxy-reporting using the 'Easy Diet Diary' app which used in this study, a recent validation study of the ASA-24 self-administered electronic dietary assessment tool indicated a high level of accuracy of foods consumed (even when recording intake that occurs when the parent was not present), but portion size reporting was less accurate (Wallace, Kirkpatrick, Darlington & Haines, 2018). As the Australian version of the ASA-24 was not yet available at the time this study was conducted, the 'Easy Diet Diary' was chosen as an alternative.

While the analyses adjusted for baseline values, child age and cohort, it is recognized that there are many potential confounders in childhood obesity studies, such as child sex, parent sex, socio-economic status, maternal education, gestational weight gain, birthweight, breastfeeding, parent BMI, and ethnicity. It is not possible to adjust for all these factors. Covariates adjusted for were determined *a priori* and were chosen as they were considered to have the potential for the most influence on results.

In conclusion, *Time2bHealthy* led to a significant improvement in frequency of discretionary food intake, parent self-efficacy (nutrition) and pressure to eat child feeding practices, but no improvement in BMI. The program has the potential for scalability and wide-reach. Future studies with a larger sample size, longer follow-up period and those that translate effective eHealth childhood obesity prevention programs into primary health care are needed.

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Chapter 5

Investigating the mediators and moderators of body mass index change in the *Time2bHealthy* childhood obesity prevention program for parents of preschool-aged children

This chapter seeks to gain an understanding of the mechanisms of change within the *Time2bHealthy* RCT. Mediation and moderation analyses were conducted to determine if change in child BMI at 6-months post-baseline was moderated by demographic characteristics or mediated by changes in obesity-related variables at 3-months post-baseline.

This chapter has been submitted and is currently under review: Hammersley M.L., Okely, A.D., Batterham, M.J., & Jones, R.A. Investigating the mediators and moderators of body mass index change in the *Time2bHealthy* childhood obesity prevention program for parents of preschool-aged children. *Childhood Obesity* (under review).

5.1 Introduction

Childhood obesity is a major problem worldwide. Interventions which aim to treat and/or prevent childhood obesity have been implemented in a range of settings and with many modes of delivery with varied success (Luttikhuis et al., 2009; Waters et al., 2011). Although there has recently been a greater focus on investigating the specific mechanisms by which such interventions achieve outcomes, there is still limited research in this area, and it has been recommended that interventions include analyses of mediators and moderators (Whittemore, Chao, Popick, & Grey, 2013; Wilfley et al., 2007b). This is particularly important in the early childhood stage where behavior change is paramount.

Mediator variables are variables which explain the mechanism for the relationship between an independent (predictor) variable and a dependent (outcome) variable. In the mediation process, the independent variable exerts an effect on the mediator variable, and the mediator variable then exerts an effect on the dependent variable. Moderator variables are variables which change either the magnitude or direction of the relationship between the independent and dependent variables (but they do not explain the mechanism for the relationship) (Hayes, 2017). Studies which explore the mediators and moderators of change are imperative as they assist in gaining a greater understanding of the contributing factors which may have an influence on an intervention achieving desired outcomes. Gaining insight into mediators and moderators that facilitate change can inform the design of more effective interventions, which can be more appropriately targeted.

There have been limited childhood obesity interventions which have explored mediators and moderators of BMI, BMI *z*-score, weight or adiposity change. The few studies conducted in this area have identified mediators such as dietary intake (Yildirim et al., 2013) and physical activity-related factors (Epstein, Roemmich et al., 2008), self-regulation, mood and self-efficacy (Annesi, Walsh, Greenwood, Mareno, & Unruh-Rewkowski, 2017). Moderators identified include age (Burke et al., 2017), baseline weight (Lubans, Morgan, & Callister, 2012), baseline dietary intake factors (Epstein, Paluch, Beecher, & Roemmich, 2008), social and psychological problems (Burke et al., 2017; Wilfley et al., 2007a), and the built environment (Epstein et al., 2012). Only one study has explored mediators of BMI change in an eHealth childhood obesity intervention, this study found that parental life and family satisfaction mediated weight loss (White et al., 2004). Only one study has explored both mediators and moderators of BMI change in childhood obesity interventions targeting preschool-aged children (Epstein, Roemmich et al., 2008).

The aim of this paper was to further explore the data from the *Time2bHealthy* RCT to investigate if change in child BMI at 6-months post-baseline was mediated by changes in obesity-related variables at 3-months post-baseline or moderated by demographic characteristics. The main outcomes of the *Time2bHealthy* RCT have been previously reported (Hammersley, Okely, Batterham & Jones, under review, see Chapter 4). Briefly, there was no significant difference in child BMI (the primary outcome) between groups. A significant reduction in the frequency of discretionary food intake among children in the intervention group compared to those in the comparison group was also reported. There was also a greater improvement in ‘pressure to eat’ child feeding practices and parent self-efficacy (nutrition) in the intervention group compared to the comparison group.

5.2 Methods

5.2.1 Study design

The *Time2bHealthy* RCT was approved by the University of Wollongong Human Research Ethics Committee (HE15/354) and registered with the Australian and New Zealand Clinical Trials registry (12616000119493) http://www.anzctr.org.au/. All parent participants gave informed written consent. The trial was conducted between January 2016 and December 2017.

5.2.2 Participant recruitment and eligibility

Eligible individuals were 2-5 year old children who were above the WHO 50th percentile for BMI for their age and sex and their parents. Children were excluded if they were taking medications or had a medical condition that could affect weight or restrict age-appropriate play. Parents were also required to have an existing Facebook account or agree to create one. Provisional eligibility was determined over the phone or via email and eligibility was confirmed at the face-to-face baseline appointment where height and weight were measured. Participants were recruited to the study from the Illawarra and surrounding areas in New South Wales and Melbourne, Victoria, Australia. Further details regarding the methods employed for this study have been previously published (Hammersley, Jones & Okely, 2017).

5.2.3 Randomization

Following baseline collection, participants were randomized into the intervention or comparison group. A computerized random number generator was used by a data manager who was not otherwise involved in the study to conduct the randomization. The only individual who was informed of group allocation was the researcher responsible for implementing the intervention. Height and weight measurements were collected by trained and blinded data collectors at the follow-up data collection time-points.

5.2.4 *Time2bHealthy* intervention

Details of the intervention have previously been published (Hammersley et al., 2017). In brief, the *Time2bHealthy* group received an 11-week online healthy lifestyle program, underpinned by Social Cognitive Theory (Bandura, 1989), comprising six modules (introduction, healthy eating (x2), physical activity, screen-time and sleep), followed by a 3-month maintenance period. The modules required participants to read content, watch videos, complete activities and set goals. A dietitian then provided feedback on the goals set. During the maintenance period, participants received fortnightly emails which revised the key information from each of the modules. Participants also had access to a closed (secret) Facebook group.

5.2.5 Comparison condition

The comparison group received 11 x weekly emails with links to information on similar topics on the evidence-based *Raising Children Network* website. Similar to the intervention group, during the maintenance period parents received fortnightly emails which revised the information sent in the previous emails.

5.2.6 Measures

Data collection was via face-to-face visits with the child/parent dyads conducted at baseline, 3-months and 6-months. Child BMI was calculated using a standardized method (National Health and Medical Research Council of Australia, 2013). Height was measured to the nearest 0.1cm using a stadiometer and weight was measured to the nearest 0.1kg using a SECA scale. Height and weight measurements were then repeated and the mean taken to calculate BMI. Where height measurements differed by more than 0.5cm and/or weight measurements differed by more than 0.5kg, a third measurement was taken.

Obesity-related behavior and parent self-efficacy measures were collected from parents via an iPad including parent questionnaires on demographics (baseline only), food intake, screen-time, sleep, self-efficacy, child feeding and role modelling. Questionnaires which had been assessed for validity and reliability were used where possible.

The food questionnaire (modified from the Eating and Physical Activity Questionnaire (EPAQ) (Bennett, De Silva-Sanigorski, Nichols, Bell & Swinburn, 2009)) assessed intake of fruit, vegetables and discretionary foods. Daily fruit and vegetable intake was measured on a continuous scale. A set of questions assessed frequency of intake of discretionary foods on an ordinal rating scale from never to two or more times per day. Responses to questions on frequency of intake of takeaway or fast food, sugary cereals, potato chips or other salty snacks, sweets, cakes, doughnuts, sweet biscuits or muffins;

and sugary drinks were then used to calculate a discretionary food score. A parent-reported 24-hour recall of child dietary intake was conducted (using the ‘Easy Diet Diary’ app (Xyris Software (Australia) Pty Ltd). Data from the 24-hour recall were used to calculate kJ per kg of body weight.

Actigraph GT3X+ accelerometers (ActiGraph Corporation, Pensacola, FL) were used to measure physical activity. Monitors were worn by children for 7-days with an elasticized belt around their waist. Data were analyzed in ActiLife version 6 (ActiGraph Corporation, Pensacola, FL). Categorization of physical activity was conducted using the following cut-points; sedentary <100 counts/min, low light-intensity physical activity 101-800 counts/min, high light-intensity physical activity 801-1679 counts/min, moderate-intensity physical activity 1680-3367 count/min and vigorous-intensity physical activity ≥3368 count/min (Pate, Almeida, McIver, Pfeiffer & Dowda, 2006).

Screen-time was measured using a set of questions (modified from (Downing, Hinkley & Hesketh, 2015; Hinkley, Salmon, Okely, Crawford & Hesketh, 2012) to ascertain the usual number of hours of screen-time per day on weekends and weekdays, which were then used to calculate overall average time per day. Sleep duration was assessed via accelerometer and parent-reported questionnaire (Sneddon, Peacock & Crowley, 2013) as usual hours per night. Parent-reported sleep duration was used for the purpose of these analyses due to poor compliance with night-time accelerometry. Parent self-efficacy was scored using a modified set of questions on a 0 to 10 scale (Bohman, Ghaderi & Rasmussen, 2013), child feeding (‘pressure to eat’ and ‘restriction’ sub-scales combined) (Birch et al., 2001) and parent role modelling (developed after reviewing (Gattshall, Shoup, Marshall, Crane & Estabrooks, 2008; Palfreyman, Haycraft & Meyer, 2014)) were assessed using a set of questions on a five-point scale.

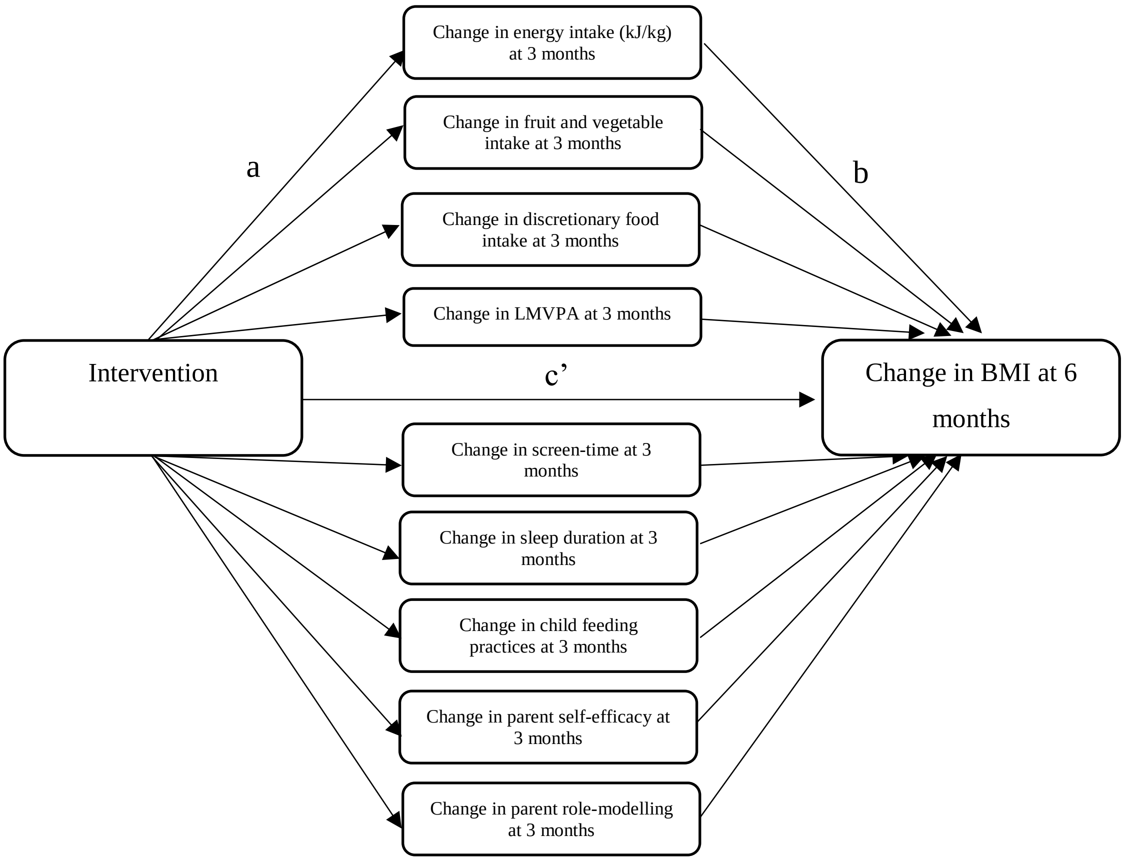
5.2.7 Statistical analysis

Mediation and moderation complete case analyses were conducted in IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA) to explore whether child BMI change at 6-months post-baseline was mediated by changes in obesity-related variables at 3-months post-baseline or moderated by participant demographics at baseline. Baseline values and child age were included as covariates in the models.

Obesity-related variables hypothesized to mediate the effect of BMI change were included in a mediation model *a priori*. Change in fruit and vegetable intake, energy intake (kJ/kg body weight), discretionary food intake, high light, moderate and vigorous-intensity physical activity (LMVPA), screen-time, sleep duration, child feeding (restriction and pressure to eat sub-scales), parent self-efficacy and parent role modelling from baseline to 3-months were hypothesized to mediate change in BMI at 6-months (**Figure 5.1**). For the purpose of this analysis, ordinal data were treated as continuous. Model four of the PROCESS Macro for SPSS version 3.0 was used to calculate the pathways. Mediation procedures outlined by Hayes (2017) were used to guide the analysis. The direct effect of the intervention on change in obesity-related variables at 3-months was determined in pathway a. The association between change in the obesity-related variables at 3-months and BMI change at 6-months was determined in pathway b. The direct effect of the intervention on BMI change was determined in pathway c'. The indirect intervention effects were determined via pathway ab. Bootstrapped 95% CIs were calculated to test if the indirect effect was significant. Mediation was determined to be significant if the CIs did not include zero.

Moderation analyses were conducted using model one of the PROCESS Macro for SPSS version 3.0. Moderation procedures outlined by Hayes (2017) were used to guide the analyses. Single moderation models were used for the baseline demographic variables of parent age, child age, parent income, parent education and parent living situation (with/without partner) to determine if there was a moderating effect of any of these variables on BMI change at 6-months.

Figure 5.1: Mediation pathway for obesity-related variables hypothesized to mediate change in BMI in the *Time2bHealthy* intervention at 6-months.



5.3 Results

Initial contact was received from 372 parents who enquired about the study and received the information sheet. 159 participants stated that they were interested and after screening 104 parent/child dyads were potentially eligible and invited to attend an initial appointment. Ninety-three parent/child dyads attended this appointment and 86 were confirmed to be eligible. Forty-two dyads were randomized to the intervention group and 44 to the comparison group. The study had a retention rate of 91%, with one participant withdrawing and 7 lost to follow-up. Further information regarding baseline demographics and participant flow have been previously reported by Hammersley et al (under review).

5.3.1 Mediation and moderation analyses

The results of the mediation analyses are displayed in **Table 5.1** and the results of the moderation analysis are shown in **Table 5.2**. Despite significant results previously reported in the main outcome analyses for frequency of discretionary food intake, child feeding - pressure to eat and parent self-efficacy (nutrition), none of the hypothesized obesity-related variables were significant mediators of BMI change at 6-months. Furthermore, none of the hypothesized participant characteristic variables were significant moderators of BMI change at 6-months.

Table 5.1: Results of mediation analysis assessing indirect effects of the *Time2bHealthy* intervention on 6-month post-baseline changes in BMI through hypothesized mediator variables

Hypothesized mediator	**c' path (SE)**	**a path (SE)**	**b path (SE)**	**Bootstrap results for indirect effects (95% CI)**		
				ab mediated path (SE)	**Lower bound**	**Upper bound**
Change in energy intake (kJ/kg)	0.023 (0.047)	5.024 (39.384)	0.001 (0.001)	0.003 (0.045)	-0.100	0.092
Change in fruit and vegetable intake	0.023 (0.047)	-0.193 (0.486)	0.011 (0.067)	-0.002 (0.042)	-0.105	0.072
Change in discretionary food intake	0.023 (0.047)	-2.162 (1.038)	-0.002 (0.028)	0.004 (0.075)	-0.143	0.170
Change in LMVPA	0.023 (0.047)	2.032 (1.941)	0.001 (0.015)	0.002 (0.468)	-0.100	0.096
Change in screen-time	0.023 (0.047)	0.514 (0.613)	0.150 (0.046)	0.077 (0.094)	-0.082	0.283
Change in sleep duration	0.023 (0.047)	0.291 (0.261)	0.081 (0.107)	0.024 (0.054)	-0.035	0.170
Change in parent self-efficacy	0.023 (0.047)	-0.101 (0.242)	-0.130 (0.115)	0.013 (0.049)	-0.055	0.148
Change in parent modelling	0.023 (0.047)	0.424 (0.208)	0.056 (0.138)	0.024 (0.074)	-0.117	0.186
Change in child feeding	0.023 (0.047)	-0.115 (0.376)	-0.047 (0.084)	0.005 (0.042)	-0.057	0.118

Table 5.2: Results of moderator analyses of the *Time2bHealthy* intervention on 6-month post-baseline change in BMI

Demographic characteristic	**Coefficient**	**95% CI**		***P* value**
		Lower bound	**Upper bound**	
Child age	0.096	-0.214	0.406	0.539
Parent age	0.000	-0.062	0.063	0.989
Parent income	-0.249	-0.631	0.133	0.198
Parent education	0.206	-0.406	0.817	0.505
Parent living situation (with/without partner)	-0.648	-1.947	0.650	0.323

5.4 Discussion

This current paper exploring the mediators and moderators of BMI change at 6-months post-baseline found no significant effect of the hypothesized mediators and moderators of the intervention on BMI change. There is an identified need for interventions that explore the mediators and moderators of change in childhood obesity interventions (Whittemore et al., 2013; Wilfley et al., 2007b) and to date there have been few studies examining mediating and moderating effects of an intervention on BMI change (Epstein, Pauluch et al., 2008, Yildirim et al., 2013, Annesi et al., 2017, White et al., 2004, Burke et al., 2017, Lubans et al., 2012, Epstein, Roemmuch et al., 2008, Wilfley et al., 2007a, Epstein et al., 2012) and only two studies which have analyzed both mediators and moderators in the same study (Epstein, Roemmich et al., 2008; White et al., 2004). There is a particular need for these analyses in studies involving preschool-aged children as only one study has explored mediators and moderators of intervention effects on BMI (Epstein, Roemmich et al., 2008). Furthermore, only one study has explored mediators of BMI change in an eHealth childhood obesity study (White et al., 2004) and no studies have explored moderators. As eHealth is a rapidly growing area of research, investigating the mechanisms by which these interventions work and whom they work for is particularly important. This paper fills an important gap in the literature, as it is one of the first to explore mediators and/or moderators of BMI change in a childhood obesity intervention in the preschool age group and the first study to explore both mediators and moderators of BMI change in an eHealth childhood obesity study in any age group.

The aim of this paper was to explore mediators and moderators of child BMI change at 6-months post-intervention in the *Time2bHealthy* RCT. The main outcomes of the RCT indicated that there was no significant difference between groups in BMI change (Hammersley et al., under review), but nevertheless, it is still worthwhile exploring potential moderators and mediators. The effect of an intervention on a mediator variable can be greater than the direct effect on the outcome variable and therefore may be a stronger indirect effect of the intervention (Yildirim et al., 2013). Mediation results may also indicate the future potential of the intervention to effect the main outcome (MacKinnon, 2011). Exploring potential moderators in interventions where there is no significant effect of the intervention on the main outcome is useful for uncovering opposing effects of an intervention based on moderating effects of participant characteristics which would not be apparent otherwise (MacKinnon, 2011).

As the majority of children in the study were in the healthy weight range, there may have been a dilution effect on BMI, which could have impacted on both the null findings in the main outcomes analysis and the null findings in the mediation and moderation analysis. Furthermore, due to the breadth of content of the *Time2bHealthy* intervention and because there were a limited number of mediators and moderators for which data were collected and included in these analyses, it is possible that other mediators and moderators that were not assessed were significant in facilitating BMI change. In the only other childhood obesity eHealth intervention which has explored mediators, White et al (2004) found that parent life and family satisfaction were significant mediators of weight loss in a family-focused eHealth childhood obesity intervention for 11- to 15-year-old children involving nutrition education and behavior change strategies for adolescents and their parents.

Only two traditionally delivered (i.e. face-to-face) childhood obesity studies have reported on mediators and/or moderators in the preschool age groups (Enö Persson, Bohman, Tynelius, Rasmussen, & Ghaderi, 2017; Epstein, Roemmich et al., 2008). The results of these studies were mixed and only one study reported a significant mediation and moderation result. BMI *z*-score change was moderated by socioeconomic status and targeted sedentary behavior had a significant mediating effect on BMI *z*-score in a study which aimed to reduce television viewing and computer use (Epstein, Roemmich et al., 2008). The intervention targeted sedentary behavior only and was therefore quite different to the multi-behavior intervention design employed in the *Time2bHealthy* study, which also focused on healthy eating, physical activity and sleep. Unlike *Time2bHealthy*, the study also enforced mandatory sedentary behaviors limits (i.e., capped time spent in sedentary behaviors) and provided the children with financial incentives for reducing TV and computer use. A device was fitted to TVs and computer monitors which prevented them from being turned on after the TV/computer budget had been exhausted. The study was also conducted over a 2-year period and therefore much longer than the *Time2bHealthy* intervention. It is possible that more time would be required to demonstrate change in BMI, particularly given the age of the children. Had a longer follow-up period been included in the *Time2bHealthy* study, perhaps mediators of change would have been detected.

A number of mediators and moderators have been found to have an effect in previous studies of older children which were not included in the mediation and moderation models in the analyses for the current study. Factors such as self-regulation, mood, child self-efficacy (Annesi et al., 2017), aerobic fitness (Maddison et al., 2012), resistance training self-efficacy, physical activity behavioral change (Lubans et al., 2012) and family factors (White et al., 2004) have mediated BMI effects. Characteristics such as social adjustment/problems (Burke et al., 2017; Wilfley et al., 2007a), anxiety (Burke et al., 2017), built environment factors (Epstein et al., 2012), baseline energy dense food intake, parent concern over own weight, and parent child acceptance (Epstein, Pauluch et al., 2008) have moderated the effect on BMI outcomes. While previous studies have had specific areas of focus, due to the wide range of mediators and moderators explored in studies, it is difficult to make comparisons and it is therefore recommended that future interventions investigate a broader range of mediators and moderators to enable results to be compared between studies. The mixed results of the mediating and moderating factors of childhood obesity interventions on BMI outcomes in the current literature demonstrate that more studies which incorporate mediation and moderation analyses are needed, particularly in interventions targeting younger children and eHealth-based studies.

5.4.1 Strengths and limitations

This is the first paper to report on both mediators and moderators in a childhood obesity eHealth intervention targeting preschool children. There are some limitations of this study. As mentioned, most children in the study were in the healthy weight range, resulting in a possible dilution effect on BMI. Therefore, it could be argued that the eligibility criteria may have been too broad. However, targeting children who are at risk of becoming overweight is important in long-term obesity prevention. Also, had the eligibility criteria been restricted to children with overweight and obesity, the trial may not have been able to proceed if a minimum sample size had not been achieved. The sample size was smaller than planned, despite strategies implemented to enhance recruitment as previously described (Hammersley et al., under review), which therefore would have affected the statistical power. It is possible that questionnaire-based data could be intentionally or unintentionally misreported by parents, a common issue to many other studies (Gemming et al., 2014; Poslusna et al., 2009). Finally, the number of mediators and moderators tested were limited by the data that were collected in the main study.

In conclusion, this exploratory analysis of the mediators and moderators of the *Time2bHealthy* childhood obesity intervention on BMI showed null results. There is a lack of studies in this area, particularly in younger children and in the field of eHealth. Further research is required, exploring a wider range of factors to gain greater insight into the mechanisms by which interventions achieve or don’t achieve outcomes, which can be used to better inform the design of more successful interventions.

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Chapter 6

Can parental engagement in social media enhance outcomes of an online healthy lifestyle program for preschool-aged children?

This chapter explores the effect of the Facebook discussion group utilized in the *Time2bHealthy* intervention. Secondary analyses are presented on the primary and secondary outcome data which sought to determine if participants who highly engaged in the Facebook group achieved superior outcomes to participants who had a lower level of engagement.

This chapter has been submitted and is currently under review: Hammersley, M.L., Okely, A.D., Batterham, M.J., & Jones, R.A. Can parental engagement in social media enhance outcomes of an online healthy lifestyle program for preschool-aged children? *Journal of Communication* (under review).

6.1 Introduction

Effective community-based, multi-component health behavior change interventions are a key component in addressing the childhood obesity epidemic (World Health Organization, 2012). To date the most effective intervention approaches are unclear, although parent-focused childhood obesity interventions which have embraced eHealth technologies have shown some promise in improving childhood obesity-related behaviors. (Chen, Weiss, Heyman, Cooper & Lustig et al., 2011; Hammersley, Jones, Batterham, & Okely, under review; Paineau et al., 2008; Williamson et al., 2005). Additionally, health behavior change interventions that incorporate interactive social media/social networking have shown potential (Thackeray, Neiger, Hanson, & McKenzie, 2008). Behavior change interventions that include a social media aspect are potentially more attractive because these methods of communication and interaction are widely utilized internationally by all different age groups (Welch et al., 2018), they are generally a cost effective addition to interventions (Moorhead et al., 2013) and often result in greater retention rates (De Bruyn & Lilien, 2008).

There is a high rate of social media usage among parents with young children (Duggan, Lenhart, Lampe, & Ellison, 2015). Parents with young children use social media sites to: keep in touch with friends and family; obtain and share information; seek and provide support and; reduce social isolation (Strange, Fisher, Howat, & Wood, 2018). Use of these sites can be a convenient and time-efficient alternative to group social support (Haslam, Tee, & Baker, 2017; O'Kane et al., 2018) at a stage of life when there is often limited time and opportunity to connect with others face-to-face due to child caring responsibilities, sleep routines and other considerations (Strange et al., 2018).

One of the main reasons parents of young children access social media sites is to help support their role as a parent (Doub, Small, & Birch, 2016; Duggan et al., 2015). Support is sought though reading information on parenting topics, asking specific parenting questions to parenting networks or obtaining social and emotional support on parenting issues (Duggan et al., 2015). Over 80% of parents who have Internet access use social media sites (Duggan et al., 2015) and social media sites offer thousands of parenting support groups (Niela-Vilén, Axelin, Salanterä, & Melender, 2014). Social media options are extensive, however one of the most popular social media sites is Facebook, with over 2 billion users worldwide (Smart Insights, 2018). In Australia, 94% of those who use social media have a Facebook account (Sensis, 2017). Facebook is the most popular choice of social media site among parents and the majority of parent users log on at least once a day (Duggan et al., 2015).

A recent review indicated that there is currently limited evidence of the efficacy of social media interventions which focus on child health (Hamm et al., 2014). A small number of interventions incorporating a social media aspect have targeted parents but few of these have focused on childhood obesity or obesity-related behaviors (Downing, Campbell, van der Pligt, & Hesketh, 2017; Fiks et al., 2017; Gruver et al., 2016; Ling et al., 2018; Ruotsalainen, Kyngas, Tammelin, Heikkinen, & Kaariainen, 2015; Swindle, Ward, & Whiteside-Mansell, 2018). These studies have included RCTs (Downing et al., 2017; Fiks et al., 2017; Ruotsalainen et al., 2015) and feasibility studies (Gruver et al., 2016; Ling et al., 2018; Swindle et al., 2018) in infant, preschool and adolescent age groups. Most studies have used social media as a component of a broader intervention (Downing et al., 2017; Ling et al., 2018; Ruotsalainen et al., 2015; Swindle et al., 2018), with the exception of Fiks et al (2017) and Gruver et al (2016), who used Facebook as the main intervention. Feasibility studies have generally reported a good level of engagement and user acceptance. RCTs have reported a high level of user acceptance and varying levels of engagement and two studies, both in infant age groups, reported positive nutrition outcomes – an increase in fruit intake (Downing et al., 2017) and an improvement in positive feeding behaviors (Fiks et al., 2017). To date, only two feasibility studies have been conducted in the preschool-age group (Ling et al., 2018; Swindle et al., 2018), with both of these studies reporting that social media is a suitable and acceptable platform to use as a component in childhood obesity-related interventions involving parents and therefore further research is warranted.

This paper aimed to determine if engagement in the Facebook component of the *Time2bHealthy* online healthy lifestyle program for parents of preschool-aged children influenced child and parent-related outcomes. It was hypothesized that participants who displayed greater levels of engagement in the social media component of the program (i.e. a closed 'secret' Facebook group) would achieve superior outcomes in change in child BMI, dietary intake, physical activity, screen-time, sleep and parent self-efficacy, parental modelling and child feeding compared to participants who had a lower level of engagement.

6.2 Methods

6.2.1 Study design

The *Time2bHealthy* RCT was conducted between January 2016 and December 2017. The trial was approved by the University of Wollongong Human Research Ethics

Committee (HE15/354) and registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12616000119493). Participants provided informed consent prior to participating. The *Time2bHealthy* online program was 11-weeks in duration with a 3-month follow-up period thereafter.

6.2.2 Participant recruitment and eligibility

Interested parents were first screened over the phone to determine provisional eligibility. Children were eligible to participate if they were 2-5 years of age and their BMI was at or above the WHO 50th percentile for their age and sex. Eligibility was then confirmed when height and weight were measured at the baseline appointment. Exclusion criteria included medical conditions or medications, which affected weight or age-appropriate play. Parents were also excluded if they did not have a Facebook account and were not willing to open one. Recruitment areas included the Illawarra region of New South Wales and surrounding areas and Melbourne, Victoria in Australia. The methods used in this study have been described in detail elsewhere (Hammersley, Jones & Okely, 2017).

6.2.3 Randomization

Randomization was conducted using a computerized random number generator to allocate participants into the intervention or comparison group after the collection of baseline measures. The person responsible for randomization had no direct involvement in the study and the researcher who implemented/facilitated the intervention was the only member of the study team to be informed of the randomization results. At follow-up data collection points, data were collected by trained data collectors who were blinded to the allocation group.

6.2.4 *Time2bHealthy* intervention

The *Time2bHealthy* intervention is described in detail elsewhere (Hammersley et al., 2017). Briefly, *Time2bHealthy* is an 11-week online healthy lifestyle program for parents of preschool-aged children which is aligned to Social Cognitive Theory (Bandura, 1989). Program module topics include healthy eating (x2), physical activity, screen-time and sleep, with each module consisting of text content, videos, activities and goal setting components. Participants received weekly emails and feedback from the facilitator (a dietitian) on the goal setting component. Post-program, participants received fortnightly emails until the 6-month follow-up time-point to recap on key information from the program.

6.2.5 Facebook component

Intervention participants from each cohort were asked to join a closed ‘secret’ Facebook group to enhance program engagement, allowing the opportunity for participants to connect with others and share ideas and experiences relevant to each module, thereby facilitating vicarious learning. Each cohort had a separate Facebook group to ensure confidentiality and encourage discussion between group members which was relevant to the module being completed at any point in time by that particular cohort.

There was one standard facilitator post per module which reminded participants to log into the website to complete the module for the corresponding fortnight and to encourage members of the group to share ideas and experiences in relation to the module that they were working through at the time. During Module 1, participants were asked to log into Facebook and introduce themselves to the group. Throughout the healthy eating modules (2 and 3) participants were asked to share recipes that they had modified to include additional vegetables and photos of healthy meals and snacks that they had tried as a result of the information provided in the modules. During Module 4, participants were asked to share photos, ideas and experiences to increase physical activity. Participants were asked to share their personal ideas and experiences in relation to reducing screen-time and improving sleep in Modules 5 and 6.

Incentives in the form of shopping gift cards were provided to encourage participants to post in the group, with one participant per module in each cohort being selected (throughout Modules 2-6) to receive a gift card. The facilitator also provided comments of encouragement and answered questions posed by participants. Additional posts were provided depending on the needs and engagement of the group (e.g. reminders for participants to post, posts in response to interest from participants on specific topics related to the modules as well as seasonal and weather-specific posts, such as healthy Christmas snacks and encouraging discussion regarding sleep routines during daylight savings transition and wet weather physical activity options). Posts and comments were monitored on a daily basis by the facilitator to ensure that the content of the online discussion was consistent with evidence-based guidelines.

6.2.6 Comparison condition

Participants in the comparison group received email links to the *Raising Children Network* website on similar topics to the *Time2bHealthy* program over an 11-week period, followed by fortnightly emails revising the material. There was no Facebook component for participants in the comparison group.

6.2.7 Measures

Data were collected face-to-face at baseline and 3- and 6-months follow-up. A stadiometer was used to calculate height to the nearest 0.1cm and a SECA scale was used to measure weight to the nearest 0.1kg. These measurements were then used to calculate BMI using a standardized method (National Health and Medical Research Council of Australia, 2013). A third measurement was taken if there was a difference of more than 0.5cm between the height measurements and 0.5kg between the weight measurements.

Parent-reported measures on demographics (baseline only), food intake, screen-time, sleep, self-efficacy, child feeding and role modelling were collected on an iPad which contained questionnaires previously assessed for validity and reliability where possible. Intake of fruit, vegetables and discretionary foods were assessed by a questionnaire (modified from the Eating and Physical Activity Questionnaire (EPAQ) (Bennett et al., 2009)). Discretionary food items included takeaway or fast food, sugary cereals, potato chips or other salty snacks, sweets, cakes, doughnuts, sweet biscuits or muffins and sugary drinks. Responses to this question were used to determine a frequency of discretionary intake score. Parents also completed a 24-hour recall of their child's dietary intake (using the 'Easy Diet Diary' app (Xyris Software (Australia) Pty Ltd)), which was used to determine kJ/kg of body weight, percentage of kJ from saturated fat and percentage of kJ from sugar.

Physical activity was measured using Actigraph GT3X+ accelerometers (ActiGraph

Corporation, Pensacola, FL). Children wore the monitors on an elasticized waist-belt for seven days. ActiLife version 6 (ActiGraph Corporation, Pensacola, FL) was used to analyze the data. The following cut-points were used to categorize activity; sedentary <100 counts/min, low light-intensity physical activity 101-800 counts/min, high light-intensity physical activity 801-1679 counts/min, moderate-intensity physical activity 1680-3367 count/min and vigorous-intensity physical activity ≥3368 count/min (Pate, Almeida, McIver, Pfeiffer & Dowda, 2006).

The usual number of hours of screen-time per day on weekends and weekdays were determined using a parent-reported questionnaire (Downing et al., 2015; Hinkley et al., 2012). Accelerometer data in conjunction with a parent-reported questionnaire (Sneddon et al., 2013) were used to determine sleep duration and sleep latency. Parents scored their self-efficacy in nutrition, physical activity and sleep via a set of questions on a 0 to 10 scale (Bohman, Ghaderi & Rasmussen, 2013). Parents reported on child feeding (‘pressure to eat’ and ‘restriction’ sub-scales) (Birch et al., 2001) and parent role modelling (developed after reviewing (Gattshall, Shoup, Marshall, Crane & Estabrooks, 2008; Palfreyman, Haycraft & Meyer, 2014)) via a set of questions on a five-point Likert scale.

Facebook group content was reviewed at the completion of the study to determine the number of facilitator and participant posts, comments and ‘likes’ for each of the modules. Participants were then categorized into ‘high engagement’ and ‘low engagement’ groups depending on the number of posts and comments from participants. High Facebook engagement was defined as posting or commenting in at least two modules and low engagement as less than two modules. This definition was determined after reviewing the data on comments and posts for each of the modules, where it was found that there was a substantial drop in the number of participants who commented or posted in three modules. Following advice from a statistician, it was decided to define high engagement as commenting or posting in at least two modules, so that each group contained enough participants for the statistical tests to run effectively. Participants were also asked to complete a process evaluation questionnaire at the end of the intervention, which included a question about the usefulness of the Facebook component.

6.2.8 Statistical analysis

Differences in changes over time between the high Facebook engagement and low Facebook engagement groups were assessed for each outcome using linear mixed models. Baseline values and age were included as covariates. Intention-to-treat principles were used for all parametric data, as such all participants were analyzed in the group which they were randomized regardless of whether they attended all data collection time-points or completed the intervention. Freidman's tests were used followed by Mann Whitney tests to analyze non-parametric data using completed cases. A P-value of $P<0.05$ was applied for the linear mixed models and $P<0.008$ (Bonferroni adjusted) was applied for the Mann Whitney U tests to determine statistical significance. All tests were conducted in IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA).

6.3 Results

Enquiries were initially received from 372 parents/carers, who were provided with an information sheet about the study. After reading the information sheet, 159 expressed an interest. After initial eligibility screening via phone or email, 104 were deemed provisionally eligible. At the baseline data collection appointment, where 93 parent/carer dyads attended, eligibility was confirmed for 86 participants. Randomization was then conducted, resulting in 42 participants being allocated to the intervention group and 44 to the comparison group. Key details regarding baseline demographics of all participants, flow through the study and participant retention and withdrawal have been published previously (Hammersley, Okely, Batterham & Jones, under review).

6.3.1 Participant characteristics

The number of participants from the intervention group who joined a Facebook group was 36 (86%). Although participants were asked at enrolment if they had a Facebook account or were willing to create one and were informed that they would be expected to join a Facebook group, there were 6 participants who did not join a group. **Table 6.1** outlines the characteristics of participants based on their Facebook engagement level. The number of participants per Facebook group ranged from 3 to 10, which aligned with differences in number of participants in each of the cohorts (i.e., small cohorts had a smaller number of participants in the Facebook group). A considerable proportion of participants (67%) ‘liked’, commented or posted on at least one module; participation in at least two modules was somewhat lower (50%). Fewer participants ‘liked’, commented or posted in at least three modules (38%). High Facebook engagement (defined as commenting or posting in at least two modules) was attained by 18 participants (43% of the intervention group and 50% of those who joined a Facebook group).

Table 6.1: Baseline characteristics of participants whom joined a Facebook group as part of the *Time2bHealthy* program

	Low engagement (n=24)	**High engagement (n=18)**	**All (n=42)**
Child sex			
Boy (%)	12 (50%)	12 (67%)	24 (57%)
Girl (%)	12 (50%)	6 (33%)	18 (43%)
Mean child age (years) (SD)	3.350 (0.795)	3.380 (0.839)	3.360 (0.804)
Mean child BMI (SD)	16.992 (0.969)	16.367 (0.714)	16.724 (0.915)
Child weight status			
Healthy Weight (%)	22 (92%)	18 (100%)	40 (95%)
Overweight (%)	2 (8%)	0 (0%)	2 (5%)
Obese (%)	0 (0%)	0 (0%)	0 (0%)
Participating parent sex			
Male (%)	2 (8%)	0 (0%)	2 (5%)
Female (%)	22 (92%	18 (100%)	40 (95%)
Mean age participating parent (SD)	36.125 (5.743)	34.556 (3.617)	35.452 (4.954)
Highest level of education of participating parent			
Not university qualified (%)	7 (29%)	1 (6%)	28 (19%)
University qualified (%)	17 (71%)	15 (83%)	32 (76%)
Currently studying (%)	0 (0%)	2 (11%)	2 (5%)
Participating parent income after tax			
<$580/week (%)	13 (54%)	7 (39%)	20 (48%)
$580-$1240/week (%)	10 (42%)	6 (33%)	16 (38%)
>$1240/week (%)	1 (4%)	5 (28%)	6 (14%)
Mean BMI participating parent (SD)	26.336 (5.172)	22.775 (2.821)	24.810 (4.636)
Weight status participating parent			
Underweight (%)	1 (4%)	1 (6%)	2 (5%)
Healthy Weight (%)	11 (46%)	14 (78%)	25 (60%)

	Low engagement (n=24)	**High engagement (n=18)**	**All (n=42)**
Overweight (%)	7 (29%)	2 (11%)	9 (21%)
Obese (%)	5 (21%)	1 (6%)	6 (14%)
Marital status participating parent			
Single/divorced/separated/widowed (%)	3 (12%)	0 (0%)	3 (7%)
Married/with partner (%)	21 (87%)	18 (100%)	39 (93%)

% - percent, SD – Standard Deviation, BMI – Body Mass Index

6.3.2 Facebook activity and engagement

Table 6.2 displays the standard facilitator posts for each module, the percentage of participants who viewed the standard post and the mean (and SD) total number of posts made by the facilitator for each module. Between 67% and 89% of participants viewed the standard facilitator posts, which varied depending on the module. Participant viewing of posts also differed according to the cohort they were in, e.g. an average of only 60% of participants viewed the standard facilitator posts in cohort 1, whereas 100% of participants in cohort 6 viewed the standard facilitator posts. There was a low level of engagement with the facilitator posts. There were only 10 comments in total to the standard facilitator posts throughout all cohorts. However, most of the activity related to the standard posts arose from participants creating their own posts in response to the facilitator posts and comments from other members on these participant posts (which were not counted as engagement with standard facilitator posts).

Table 6.2: Facilitator posts delivered as part of the *Time2bHealthy* program

Module	Standard facilitator post	% of participants that viewed standard facilitator post	Mean (and SD) facilitator posts per Module
1	"Welcome to *Time2bHealthy* everyone! Please feel free to introduce yourself, post tips and ideas that you would like to share and issues that you would like to discuss with others. The idea of this Facebook group is to discuss and share ideas and experiences on each of the topics as we move through the *Time2bHealthy* program. Sometimes the best advice can come from other parents who are in a similar situation as you".	80%	1.00 (0.00)
2	"Hi everyone, I hope you are enjoying Module 2 and that you are finding the discussion on the Facebook page useful. Just a reminder that it would be great to share a recipe that you have modified to increase the amount of vegetables. A photo would also be great. The more recipes, the better! We are offering a $20 shopping gift card for the best modified recipe of the week".	89%	2.33 (0.52)
3	"Hi everyone, with Module 3 now open, over the next couple of weeks it would be great if you could take a photo and share your favourite healthy snack with others in the group. We are offering a $20 shopping gift card for one of our participants".	86%	2.33 (0.82)
4	"As we turn our focus to physical activity in Module 4, please remember to share any tips and ideas that you have. Do you have any equipment that you find helps to keep your family active? One post will be selected to receive a $20 shopping gift card at the end of this module".	67%	2.83 (1.72)
5	"As we turn to screen-time in Module 5, please remember to share any tips and ideas that you have. One post will be selected to receive $20 shopping gift card at the end of this module".	78%	2.67 (2.16)
6	"As we start the final module on sleep, please remember to share any experiences, tips and ideas that you have. One post will be selected to receive s $20 shopping gift card at the end of this module".	83%	2.83 (1.47)

Table 6.3 outlines the participant activity across all program modules. The total number of participant posts across all modules was 58 (an average of 1.6 per group member), the total number of participant comments across all modules was 99 (an average of 2.8 per group member) and the total number of likes was 135 (an average of 3.8 per group member). There was a high degree of variation between participants, with two participants contributing seven posts each and 16 participants not posting or commenting at all. Posts also varied according to the cohort: generally larger cohorts had more posts and comments per member than smaller cohorts. Cohort 1, which was the largest (10 members), had an average of 2.8 posts per member. Cohort 5, which was the smallest (3 members), had no participant posts at all. The module with the highest level of participant engagement was Module 2 (healthy meals) and Module 3 (healthy snacks and drinks) was the lowest level of participant engagement.

Table 6.3: Participant Facebook activity across all modules of the *Time2bHealthy* program

	Module 1	**Module 2**	**Module 3**	**Module 4**	**Module 5**	**Module 6**	**Total**
'Likes'	4	31	19	38	28	15	135
Comments	8	26	4	25	23	13	99
Posts	1	20	9	11	11	18	58
Total activity	13	77	32	74	62	46	292

The content of most of the participant posts and comments were largely in response to the standard facilitator post and therefore featured ideas and experiences in relation to the respective modules that they were working through, including photos and recipes of healthy meals, photos and/or descriptions of healthy snacks, physical activities, screen-time alternatives and sleep routines. Some participant posts focused on clarification of some of the content in the modules e.g. reduced-fat dairy recommendation and other posts asked questions about website functionality e.g. accessing feedback on goals. Some examples of participant posts for each of the modules are displayed in **Table 6.4**. While the dietitian monitored the Facebook groups daily to ensure that discussion was consistent with evidence-based guidelines, there was little need to intervene as posts and comments were largely in line with current guidelines. As mentioned above, in one instance, there was a post questioning the need to change to reduced fat dairy products. This prompted comments from other members of the group about their experiences and the advice that they had received. The dietitian moderating the group responded to this post and the associated comments respectfully by acknowledging the viewpoints of the original poster and the other members of the groups that had responded. The dietitian clarified which parts of their statement were correct and then explained the rationale for the reduced fat guideline for children over the age of two. The dietitian ensured that the tone of the post was friendly and conversational and encouraged further discussion.

6.3.3 Primary and secondary outcomes

Table 6.5 displays the baseline, 3-month and 6-month BMI results according to their Facebook engagement level and results of the intention-to-treat analysis. There was no group by time effect for BMI.

The linear mixed model analyses found a significant group by time interaction for sleep duration (estimate 0.401, 95% CI 0.031 to 0.771, *P*=0.035) and percentage sedentary time (estimate -2.972, 95% CI -5.714 to -0.230, *P*=0.035). There was also a significant group by time interaction for kJ/kg in the non-hypothesized direction (estimate 86.824, 95% CI 22.136 to 151.512, P=0.010). No other group by time interaction effects were found. **Table 6.6** displays the results of the non-parametric tests, where no significant results were found for any parameter.

Table 6.4: Participant Facebook post examples from the *Time2bHealthy* program

Module	Participant post example
2	*"One of my current favourites for sneaking veg in is a baked meatballs recipe I found online, served with carrot and zucchini 'spaghetti'. It has spinach and potato hidden in the meatballs and both kids gobble it down".*
3	*"One of my daughter's favourite healthy snacks has been the beans we grew in the garden. These were the last of them, unfortunately, and she kept asking me if she could eat them while I was making tea. She hasn't been that keen on beans before. Not sure if they are sweeter when they are eaten fresh, or if she just enjoyed picking them. Although she wouldn't eat the cherry tomatoes she picked".*
4	*"My son love love loves swimming. This is him trying to catch a ball. Our local pool is indoor so we can go all year round regardless of the weather".*
5	*"Some of the strategies I have put in place this week to reduce our screen-time (I needed to drop 1/2 an hour to 1.5 hours a day roughly) have been:* *- Get my pre-schooler involved in cooking dinner with me and I have set up the play kitchen next to my kitchen so my one year old "cooks/goes shopping" when I am cooking"* *- Organised the card games/ puzzles/ dominos and have been getting these out for quiet time while my one year old has her nap.* *- Starting going back to the local library to get some new books into the household to encourage more reading.* *- My 3 year old started an "about me" folder which includes cutting and pasting pictures which he relates to (photos, favourite foods, activities, stickers etc) into the folder which he can show to people and talk about.* *- Making sure I put away the different types of toys and bring them out separately so they stay engaged/ play with a variety of things and the house doesn't get completely trashed!* *- So far we are doing ok but it is very tempting to put the TV on so I can do tasks around the house by myself. Anyone else come up with some good strategies to reduce screen-time?"*
6	*"Some sharing on bedtime routine* *- We teach our girl how to read the clock. So when the set bedtime comes, she looks at the clock and knows it's the time to go to bedroom. Less arguments occur.* *- When she was younger we set the alarm clock and when it ringed, she understood bedtime started now.* *- We put a small bookshelf in her bedroom and keep the books only being read during bedtime. Somehow this makes her looking forward to bedtime so she can hears those stories.* *- Set the rule that how many stories you are going to read. For us we only read one. If no rules she will ask one story after another. Make her more awake or overtired.* *- Get changed in pyjamas also makes her know sleep time is about to come especially for younger kids. I will involve her when buying pyjamas. She's happy to be in beautiful pyjamas too.* *- Our bedtime routine: Say goodnight to everyone in the house -> bath (if not done so before dinner) -> brush teeth -> get changed in pyjamas-> read a story chosen by her -> sing a song -> cuddle and kiss -> turn night light on -> she sleeps on bed and I leave her room".*

Table 6.5: Mean values (and SD) and intention-to-treat analyses based on level of engagement in *Time2bHealthy* Facebook group

Variable	**Baseline**		**3-months**		**6-months**		**Estimate***	**95% CI**		***P*-values***
	Low FB engagement	**High FB engagement**	**Low FB engagement**	**High FB engagement**	**Low FB engagement**	**High FB engagement**		**Lower Bound**	**Upper Bound**	
BMI	17.046 (1.018)	16.367 (0.714)	16.577 (0.887)	15.986 (0.704)	16.786 (0.765)	16.120 (0.622)	0.046	-0.232	0.323	0.740
kJ/kg of body weight [a]	386.416 (109.762)	318.971 (106.007)	272.149 (120.599)	339.607 (116.031)	298.881 (104.889)	361.379 (95.173)	86.824	22.136	151.512	0.010
Percentage of kJ from sugar[b]	19.802 (5.335)	20.903 (9.414)	20.615 (6.531)	20.669 (5.455)	20.850 (8.257)	18.011 (4.819)	-1.103	-4.294	2.088	0.487
Percentage of kJ from saturated fat[b]	12.300 (4.366)	10.588 (3.759)	14.850 (8.659)	18.118 (9.949)	10.450 (4.123)	11.647 (3.639)	2.068	-1.649	5.785	0.266
Serves of fruit[c]	2.250 (0.786)	3.000 (0.907)	2.400 (0.754)	2.556 (0.922)	2.500 (0.827)	2.556 (0.922)	-0.058	-0.627	0.511	0.837
Serves of vegetables[c]	2.600 (1.314)	2.833 (1.249)	2.850 (1.309)	2.833 (1.150)	3.000 (1.338)	2.944 (1.259)	-0.249	-0.682	0.185	0.252
Discretionary food frequency score[c]	11.500 (4.059)	10.722 (3.878)	11.050 (3.471)	8.444 (2.281)	10.550 (3.531)	10.222 (2.922)	-1.055	-2.459	0.348	0.136
Child feeding – Restriction[d]	3.581 (0.644)	3.583 (0.910)	3.850 (0.605)	3.521 (0.866)	3.669 (0.787)	3.653 (0.820)	-0.159	-0.488	0.170	0.334
Child feeding – Pressure[d]	2.392 (0.730)	2.472 (1.242)	2.150 (0.991)	2.194 (1.196)	2.275 (0.959)	1.986 (1.031)	-0.175	-0.545	0.194	0.348
Sleep duration (hrs)[e]	9.513 (0.632)	10.185 (0.663)	9.470 (0.506)	10.145 (0.420)	9.285 (0.662)	9.768 (0.626)	0.401	0.031	0.771	0.035

Variable	Baseline		3-months		6-months		Estimate*	95% CI		*P*-values*
	Low FB engagement	High FB engagement	Low FB engagement	High FB engagement	Low FB engagement	High FB engagement		Lower Bound	Upper Bound	
Sleep reluctance[f]	2.667 (1.237)	2.000 (7.670)	2.222 (1.060)	2.000 (0.840)	2.444 (1.294)	2.000 (0.970)	0.006	-0.608	0.620	0.984
Percentage sedentary time[e]	48.067 (6.942)	47.573 (8.113)	49.520 (3.909)	47.898 (4.151)	51.514 (4.188)	46.671 (6.028)	-2.972	-5.714	-0.230	0.035
Percentage LMVPA[f]	25.815 (5.942)	27.352 (7.734)	25.440 (4.218)	26.605 (4.854)	24.822 (4.040)	26.511 (5.898)	1.006	-1.670	3.682	0.446
Percentage MVPA[f]	12.013 (3.637)	12.781 (4.336)	12.793 (3.276)	13.503 (4.501)	12.919 (3.432)	13.368 (4.320)	0.292	-1.495	2.078	0.740

*n=42 - Linear mixed model (random intercept, compound symmetry covariance structure) adjusted 6-month difference. Age, cohort and baseline values included as covariates in the model. Significant at $P<0.05$; [a]Calculated from 24-hour diet recall using Easy Diet Diary/Foodworks; [b]From Food Questionnaire, [c]Scored from food questionnaire questions on frequency of intake of takeaway or fast food; sugary cereals; potato chips or other salty foods; sweets; and cakes doughnuts, sweet cookies or muffins. Responses of never or rarely; 1-3 times per month; 1-2 times per week; 3-4 times per week; 5-6 times per week; once per day; and 2 or more times per day were coded as 1-6 respectively and summed to obtain a discretionary food score; [d]Child feeding questionnaire; [e]Accelerometer-measures [f]From sleep questionnaire. BMI – Body Mass Index, kJ – kiloJoules, hrs – hours, LMVPA – light-, moderate- to vigorous-intensity physical activity, MVPA - moderate- to vigorous-intensity physical activity.

Table 6.6: Median values (and IQR) for non-parametric variables based on level of engagement in *Time2bHealthy* Facebook group (complete case analysis)

Variable	**Baseline**		**3-months**		**6-months**	
	Low FB engagement (n=20)*	**High FB engagement (n=18)***	**Low FB engagement (n=20)***	**High FB engagement (n=18)***	**Low FB engagement (n=20)***	**High FB engagement (n=18)***
Sugary drinks frequency[a]	1.000 (0.750)	1.000 (1.000)	1.000 (0.000)	1.000 (0.000)	1.000 (1.000)	1.000 (0.000)
Fruit juice serves per day[a]	0.000 (0.000)	0.000 (0.250)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Water serves per day[a]	5.000 (0.750)	5.000 (2.000)	5.000 (2.000)	5.000 (3.000)	5.000 (2.000)	5.000 (2.000)
Self-efficacy (nutrition)[b]	7.917 (1.583)	8.373 (1.250)	8.667 (0.667)	9.000 (1.917)	9.000 (1.667)	9.000 (1.833)
Self-efficacy (physical activity)[b]	8.125 (2.000)	9.000 (2.125)	8.250 (1.438)	8.853 (2.500)	8.625 (1.188)	9.500 (1.375)
Self-efficacy (screen-time)[b]	7.000 (1.875)	8.000 (2.500)	8.000 (1.125)	8.500 (3.000)	8.000 (1.000)	9.000 (2.500)
Self-efficacy (sleep)[b]	9.000 (2.000)	9.000 (2.000)	9.500 (2.000)	10.000 (2.500)	10.000 (2.000)	10.000 (2.000)
Frequency watching TV while eating meal[c]	2.000 (2.000)	2.000 (1.000)	1.500 (1.000)	1.000 (1.000)	1.500 (1.000)	1.000 (1.000)

Variable	Baseline		3-months		6-months	
	Low FB engagement (n=20)*	**High FB engagement (n=18)***	**Low FB engagement (n=20)***	**High FB engagement (n=18)***	**Low FB engagement (n=20)***	**High FB engagement (n=18)***
Difficulty falling asleep[d]	2.000 (2.250)	2.000 (2.250)	2.000 (1.000)	1.500 (1.250)	2.000 (2.250)	1.500 (1.250)
Does not fall to sleep in own bed[d]	1.000 (0.250)	1.000 (1.000)	1.000 (1.000)	1.000 (0.250)	1.000 (1.000)	1.000 (1.000)
Sleep latency (min)[e]	30.571 (17.143)	14.833 (16.341)	20.286 (24.105)	15.000 (24.100)	19.667 (28.524)	18.400 (16.298)
Parent modelling[f]	4.250 (1.250)	4.125 (0.880)	4.500 (0.750)	4.375 (0.810)	4.500 (0.750)	4.500 (0.750)
Screen-time – Weekday (hrs)[g]	2.000 (2.375)	0.7500 (1.833)	1.000 (1.208)	0.500 (1.917)	1.167 (1.250)	1.000 (1.708)
Screen-time – Weekend day (hrs)[g]	2.875 (3.125)	1.500 (1.375)	2.000 (1.833)	1.500 (1.625)	2.583 (1.875)	1.500 (1.500)

No significant differences between groups at *P*<0.008 (Bonferroni adjusted). [a]From Food Questionnaire, [b]From self-efficacy questionnaire, [c]From screen-time questionnaire, [d]From sleep questionnaire, [e]From accelerometry data, [f]From parent modelling questionnaire, [g]From screen-time questionnaire.

*The actual number of observations at Baseline varied from 9 to 20 in the low FB engagement group and 9 to 18 in the high FB engagement group. The number of observations at 3-months was varied from 9 to 20 in the low FB engagement group and varied between 9 to 18 in the high FB engagement group. The number of observations at 6-months was 9 to 20 in the low FB engagement group and 9 to 18 in the high FB engagement group. IQR – Interquartile Range, TV – television, min – minutes, hrs – hours.

6.3.4 Process evaluation

Thirty-seven intervention group participants (88%) completed the process evaluation questionnaire. Despite a high level of user acceptability of the *Time2bHealthy* program overall, the details of which have been previously reported (Hammersley et al., under review), only 15 participants (41%) agreed or strongly agreed that the Facebook component was useful.

6.4 Discussion

Parent-targeted health behavior change interventions that incorporate social media components have great potential as parents of young children are active users of social media sites. Surprisingly there have been few child health interventions involving parents which have included a social media component and very few of these have targeted childhood obesity or obesity-related behaviors. The aim of this paper was to explore the level of participant engagement in the Facebook component of the *Time2bHealthy* program and to determine if the level of participant engagement influenced child health-related outcomes. This is one of the first studies to explore the effect of a parent-focused social media component of an online intervention on BMI and obesity-related behaviors.

There was a high level of membership of the Facebook groups and the majority of participants posted, commented or ‘liked’ in at least one of the six modules. These results compare favorably with other similar studies (Downing et al., 2017; Swindle et al., 2018). There was variation in the level of engagement across the different modules and between the different cohorts/Facebook groups, which is also similar to other studies (Downing et al., 2017; Swindle et al., 2018). In groups with more members, there were generally more comments per member. It appears that there needs to be a minimum core group to elicit more engagement, which was highlighted by the smallest group of three participants which had no posts at all. Engagement was also likely influenced by participants' level of interest or need in regard to respective topics. Participation in the Facebook group was not compulsory, unlike the online program – where it was necessary to complete one module before progressing to the next. This may have had an influence on engagement and given that it was an additional component to the intervention, participants may have decided not to invest time in it.

Participants were generally unknown to each other. Had participants been familiar with each other, the engagement level may have been higher. For example, if they had been a member of the same playgroup or preschool, or if there had been face-to-face sessions which had allowed members of the group to get to know each other, they may have been more willing to post and share information with the group. However, the evidence in the literature is divided on this topic. A physical activity Facebook intervention for new Mums, which used a 'snowballing' form of recruitment by users inviting friends to join, reported a high level of engagement (Kernot, Olds, Lewis, & Maher, 2014). Therefore, recruiting existing friendship groups may be an avenue to explore to enhance engagement in interventions with a social media component but would present challenges in designing RCTs unless randomization was done at the group level. However, in another study, familiarity with other Facebook group members did not result in a higher level of engagement in a nutrition and physical activity program for parents of infants which involved face-to-face sessions (Downing et al., 2017). Previous research has highlighted concerns regarding participant views on confidentiality of information posted (Moorhead et al., 2013) and some studies have indicated that participants may be more likely to share information if they are not known to other participants as they may feel that it is a less threatening environment to openly share information and seek help online (Haslam et al., 2017).

Some modules were more popular than others. With the exception of the healthy snacks and drinks module, there was a trend for decreasing engagement over the duration of the program, which was consistent with overall program engagement and completion rates. The healthy snacks and drinks module may have been less appealing for participants as this directly followed the other healthy eating module and participants may have discussed all that they had needed to during the previous module. Generally, participants who did not complete the program either did not join the Facebook group, had low levels of engagement or dropped off in engagement over the course of the program.

In this study, we found no significant difference in BMI change between the participants who highly engaged in Facebook compared to participants who had a lower level of engagement. There were also no significant differences in screen-time, child feeding, parental role-modelling or parent self-efficacy between these two levels of Facebook engagement.

Positive outcomes were demonstrated for parents who highly engaged in Facebook compared to those who had a lower engagement level in relation to percentage sedentary time and sleep duration in the hypothesized direction. These findings may be related to the relatively high number of participant posts in these modules. The sleep and screen-time modules elicited the second and third highest number of posts respectively and it is possible that members of the group obtained more benefits through vicarious learning from other members of the group by viewing other participants' experiences and ideas than through the website module content. The sleep module of the website contained only one video, whereas other modules contained at least three videos. Therefore, throughout the sleep and screen-time modules, participants may not have obtained vicarious learning through the website content, but have gained benefit from the additional sharing of ideas and experiences of others in the Facebook group.

There was a significant group by time interaction in relation to kJ intake per kg of body weight in the non-hypothesized direction. The reason for this finding is unclear. It may be possible that participants who found reducing kJ intake challenging used the Facebook group more to seek further information and support. The amount of kJ/kg does not provide details on the type of food consumed and as there was a reduction in frequency of discretionary food intake overall in the intervention group in the main analysis, it is possible that the type of foods being consumed were core healthy foods rather than discretionary foods. This ambiguous finding may also have been due to the fact that the kJ measurement was based on a single 24-hour recall at each time-point and was probably not an optimal representation of usual dietary intake.

Careful consideration was given in regard to the type of social media platform employed for the current study from the many options available. In the formative research for this study, a discussion board was used which was integrated into the web application (Jones, Wells, Okely, Lockyer & Walton, 2011). This forum allowed for easy searching of posts through threads and an easy administration process as there was no need to add members to groups. However, as the use of discussion boards has declined over recent years, it was anticipated that participants would be more likely to engage in more modern forums, such as Facebook and other social media. The discussion board also did not notify participants of any new posts, so there was usually a delay with interactions between participants.

In a systematic review on social media use in child health, it was suggested that researchers harness technology platforms that people are already using (Hamm et al., 2014). Due to the surge in popularity of Facebook and the rising use of parenting groups on Facebook, the use of this platform was explored. The free accessibility, high number of current users, familiarity, ease of use, immediate access/notification of posts and accessibility on a variety of devices were important factors in selecting Facebook for use in this study. Some problems were encountered though that would not have been experienced with a discussion board. Several participants couldn’t remember the email address that they signed up to Facebook with, which was needed to invite members to the group. This issue was resolved, but was time-consuming for the facilitator and participants. Technical issues have also been reported in previous studies (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004; Welch et al., 2018). The way in which posts appear in the group may have been difficult for participants to navigate. It was not always the most recent posts that appeared first. Popular posts sometimes appeared ahead of the current posts and participants may have had to search for posts on the latest module topic, which could have affected engagement. Although links to the Facebook group were embedded in the web application, the additional step required to access the group may also have been a barrier to engagement. Another possible disadvantage of using a Facebook group is the spread of misinformation, which has been widely documented (Welch et al., 2018; Westberg, Stavros, Smith, Munro, & Argus, 2018). This risk was negated in this study as the groups were monitored by the facilitator to ensure that any information that was discussed was consistent with evidence-based guidelines. Past research has highlighted the advantages of peer-support and also stressed the importance of a professional facilitator being involved (Niela-Vilén et al., 2014). Further research is suggested to investigate the most appropriate social media platform to be utilized for parent-focused childhood obesity interventions, which is difficult given the rapidly changing landscape in this space. It is important for researchers to keep abreast with current trends and explore the feasibility of popular platforms for use in interventions.

Facebook and other social media sites allow users to access information and engage with others at a time that is convenient to them. The *Time2bHealthy* Facebook component therefore offered parents the flexibility of accessing it at a time which suited their schedule, enabling them to work around children's sleep and activity times. As noted in a previous review of Internet-based studies for parents, night-time is often the only time of day that parents have the time required to participate in programs, making the online medium an ideal fit for this group (Niela-Vilen et al., 2014).

The significant findings of this Facebook analysis are different to the significant outcomes reported in the main outcomes of the study, indicating that engagement in the

Facebook component of the program had a unique effect on outcomes, which varied from the effect of the overall program. No significant differences in BMI change between participants whom were rated as being highly engaged in the Facebook component of the intervention compared to participants who had a lower level of engagement were found. The null BMI outcome is consistent with the outcome of the main study and is likely due to the large proportion of children in the healthy weight range and the underpowered sample size, as previously discussed (Hammersley et al., under review). To the best of the author’s knowledge, only three other childhood obesity interventions incorporating a social media component have assessed BMI/BMI *z*-score change, which have been in infants (Downing et al., 2017), preschool-aged children (Ling et al., 2018) and adolescents (Ruotsalainen et al., 2015) and none have reported a significant BMI/BMI *z*-score outcome. Although the Ling et al (2018) feasibility study in preschool-aged children had no significant BMI result, they did report a -0.30 effect size in their small sample. The general potential of a social media intervention to impact on BMI in adults was demonstrated in a meta-analysis which reported a one point decrease in BMI (An, Ji, & Zhang, 2017).

6.4.1 Strengths and limitations

This study is one of the first to explore the effect of parent engagement in a social media component of a childhood obesity prevention intervention and therefore makes a valuable contribution to the literature. There are a number of limitations of this study. The Facebook groups were used at a very basic level. Additional functionality that could have been used include polls, scheduled posts, events, uploading documents and development of a specific Facebook app. These features were not utilized as Facebook was used in this intervention as a component to supplement the main online program rather than a standalone intervention. The process evaluation for this study included only one question about Facebook usage. Participants were not asked if they would have preferred a different discussion medium, or about the facilitator posts and what could have been improved. Further qualitative research on what aspects of the Facebook group were helpful is recommended. Although participants were categorized into high and low engagement, it is not possible to determine if participants who do not engage by liking, commenting or posting are gaining a benefit by just viewing the posts and comments of others. The definition and categorization of "low" and "high" Facebook engagement was not determined *a priori*, but based on opportunistic categorization of users into groups to ensure adequate numbers across both groups to facilitate statistical analysis. In fact, posting or commenting in at least 2 out of 6 modules could be considered low. However, with the small number of studies conducted in this area and the varying methods employed, it was not possible to base this definition/categorization on previous studies.

6.5 Conclusion

The results of this study indicated that high engagement in a Facebook component to an online healthy lifestyle program for parents of preschool-aged children did not result in superior changes in BMI compared to participants with low engagement but did result in positive changes in sedentary behavior and sleep duration. There were also ambiguous results indicating an increase in kJ/kg intake in the high engagement group. There was moderate user acceptability of the Facebook group and the majority of participants joined and engaged on at least one instance with the group. This is one of the first parent-focused childhood obesity interventions with a Facebook component which has assessed the effect on BMI. More research is warranted with larger sample sizes and longer duration to further explore the potential of social media in parent-focused childhood obesity prevention interventions.

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Chapter 7

Discussion

7.1 Overview

The aim of this research was to investigate the efficacy of the *Time2bHealthy* online program in facilitating change in BMI and obesity-related behaviors among preschool-aged children who are overweight, or at-risk of becoming overweight. The thesis consisted of five papers which addressed the aims and research questions. Chapter 2 highlighted the gaps in the literature in regard to parent-focused eHealth childhood obesity interventions and BMI/BMI *z*-score outcomes. A number of the gaps were addressed in the development of the *Time2bHealthy* intervention. Chapter 3 outlined the methods for the research. Chapter 4 presented the primary and secondary outcomes of the *Time2bHealthy* RCT. Chapter 5 explored potential mediators and moderators of BMI change in the *Time2bHealthy* RCT and Chapter 6 explored the effect of the *Time2bHealthy* Facebook discussion group on primary and secondary outcomes.

This chapter will present an overall discussion of the research. The results of the research will be considered in relation to the research questions and will be compared with the most recent body of literature. Strengths and limitations will then be discussed and recommendations for future research will be proposed, followed by an overall conclusion.

7.2 Introduction

To date, there have been limited RCTs which have investigated the efficacy of parent-focused eHealth childhood obesity interventions in reducing BMI. In the literature review (Chapter 2), none of the identified studies (0 out of 10) found a significant reduction in BMI or BMI *z*-score. Of these studies, just under half demonstrated significant improvements in dietary intake or physical activity measures (Chen, Weiss, Heyman, Cooper, & Lustig, 2011; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006). To date, only two eHealth childhood obesity interventions have targeted children under the age of five, both of which were published in the last 12 months and only one of these studies was in the preschool age group (van Grieken et al., 2017; Wald, Ewing, Moyer, & Eickhoff, 2018). Given that parental influence is crucial at the early childhood stage, there is a need for more studies to be conducted in this age group. Several gaps and limitations in the reviewed literature were highlighted at the conclusion of Chapter 2 and included: the quality of studies, most of which were of poor quality, ambiguity regarding the level of integration of behavior change theory into interventions, low retention rates, short duration, and lack of follow-up in some studies. Only one study was identified that used eHealth as the sole delivery medium. The literature review highlighted the need for better methodological quality interventions, which are closely aligned to behavior change theory and include strategies to maximize retention rates. Additionally, trialing the use of an intervention which uses eHealth as the sole mode of delivery was suggested, as parents may find it easier to maintain engagement with an intervention which has a lower level of complexity, offers more flexibility and requires less time and travel commitments. This research sought to fill these gaps.

7.3 Key findings

Primary research question:

1. What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on child BMI?

Chapter 4 described the outcomes of the RCT which investigated the efficacy of the *Time2bHealthy* online behavior change program for parents of preschool-aged children. No significant differences in BMI change between the intervention and comparison groups at 6-months post-baseline were reported. Significant within-group differences in BMI in the intervention group at both the 3- and 6-month time-points were reported.

This null finding is congruent with other eHealth childhood obesity studies which have included children under the age of five years (van Grieken et al., 2017; Wald et al., 2018) and older children (Baranowski et al., 2003; Chen et al., 2011; Davis, Sampilo, Gallagher, Landrum, & Malone, 2013; Estabrooks et al., 2009; Paineau et al., 2008; Williamson et al., 2005; Wright et al., 2013) and a recent mHealth study in preschool-aged children which used fat mass index as the outcome measure (Nystrom et al., 2017). As limited eHealth RCTs have been conducted in the preschool age group, findings were also compared with traditionally delivered studies, which have had mixed results. A recent meta-analysis of obesity interventions in early childhood (0-6 years) found a short-term, but no long-term effect on weight status, and the studies that targeted only overweight and obese children demonstrated better outcomes (Yavuz, van Ijzendoorn, Mesman, & van der Veek, 2015). As mentioned in Chapter 4, significant changes in BMI in this RCT may therefore have been unlikely given that >90% of the children involved in the study were in the healthy weight range. Had healthy weight children been excluded, the BMI outcomes may have been more favorable. However, prevention is fundamental in tackling childhood obesity and it is therefore important that interventions are also offered to children at-risk of overweight and obesity to help establish and maintain healthy behaviors at an early age (Gruber & Haldeman, 2009). Recruitment would also have proven even more challenging if only overweight and obese children were included.

The null results could also have been due a number of other factors. Although the sample size was similar to other studies (Chen et al., 2011; Davis et al., 2013; Wald et al., 2018; Williamson et al., 2005; Williamson et al., 2006; Wright et al., 2013), the compromised power of the study may have resulted in the null findings. It is possible that parents may have enrolled into the study, but then had low motivation to participate in and complete the study. Parents were not asked specifically about their motivation throughout the study, however >80% of participants completed at least five modules suggesting that parent motivation was quite high. It is also possible that parents found the breadth of information provided in the program overwhelming. Modules focused on healthy eating, physical activity, screen-time and sleep. Although careful consideration was given to the content to ensure that it was manageable, and the process evaluation results indicated that the content and amount of information was acceptable to parents, it is possible that some parents still considered the information overwhelming and chose not to engage enough in the program content to elicit change. This could be a valuable point to consider in future iterations of the program.

Sub research questions:

1.1 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on child:

a) Dietary intake (energy intake, sugar intake, saturated fat intake, fruit and vegetable intake, discretionary food intake and sugar-sweetened beverage intake)
b) Physical activity
c) Screen-time
d) Sleep

a) Dietary intake

The *Time2bHealthy* RCT demonstrated a significant group by time interaction in regard to frequency of discretionary food intake. However, there were no significant differences for any other dietary intake outcomes between the intervention and comparison groups (See Chapter 4).

Similar improvements in consumption of energy dense foods have been shown in other parent-focused eHealth RCTs targeting children under five years of age (Harvey-Berino & Rourke, 2003; Louzada, Campagnolo, Rauber, & Vitolo, 2012). Similar to *Time2bHealthy*, Williamson et al (2006) reported a significant reduction in 'eating fattening foods', however, unlike the *Time2bHealthy* study, the target group for the study was adolescent overweight girls. Other studies have demonstrated improvements in other dietary intake measures. For example, an Internet-based study of adolescents (Chen et al., 2011) and an Internet-based study for mothers of 4-to 6-year-old children (Knowlden & Conrad, 2018) both reported improvements in fruit and vegetable intake and an Internet-based parent-focused intervention targeting children aged 18-24 months reported a reduction in sugar-sweetened beverage intake (van Grieken et al., 2017). Improvements in fruit and vegetable consumption (Haire-Joshu et al., 2008) and energy intake have also been reported in some traditionally delivered parent-focused interventions in preschool-aged children (Shelton et al., 2007).

The null findings in relation to energy intake (kJ/kg body weight) and percentage of kJ from sugar and saturated fat in this study may have been at least partly due to the data collection method employed. Due to limited resources, the 24-hour recall, which was used to measure energy intake and percentage of kJ from sugar and saturated fat, was based on one single weekday of intake and may not have been adequate in assessing overall dietary intake patterns as data on weekend consumption were not obtained. In contrast the food questionnaire that assessed other aspects of dietary intake (including discretionary food intake) focused on 'usual' intake.

b) Physical activity

There were no significant differences in physical activity outcomes between the intervention and comparison groups. In this study sub-optimal accelerometry compliance rates were reported and therefore the results may have not be representative of the sample as a whole. Despite a number of techniques employed to maximize the compliance, only 53 to 68 participants (depending on the time-point) were compliant for at least six hours per day on three days. However, the retention rate of this study was good (>90%), whereas many other studies have reported a much higher loss to follow-up (Metcalf, Henley, & Wilkin, 2012). In this study, children wore the accelerometers while in their own home, in the care of friends or family members or at preschool (where it was likely that no other children were wearing accelerometers). A recent methodological review of RCT using accelerometers found that most studies were conducted in the school/preschool setting (Howie & Straker, 2016). Studies which have been conducted in this setting generally appear to have good rates of compliance (Razak et al., 2018; Ruiz et al., 2018), which may be because children are more accepting of wearing them when their peers are also wearing them. This issue of social conformity has been raised in previous research, which reported that children may feel like they stand out or fear being bullied if they are the only child wearing the device (McCann, Knowles, Fairclough, & Graves, 2016). It has been suggested that strategies be employed such as use of text messages, sticky note reminders, daily contact, rewards and individual feedback on accelerometer results to improve compliance (McCann et al., 2016), which could be explored in future studies. It is possible that engaging both children and parents in wearing a device could by a useful strategy to improve compliance.

Physical activity outcomes have been mixed in similar eHealth parent-focused studies (Chen et al., 2011; Davis et al., 2013; Haerens et al., 2006; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006). Pedometers were used as a tool to self-monitor activity in one successful Internet-based intervention which targeted adolescents (Chen et al., 2011), which may have contributed to the positive outcomes through increasing motivation and self-efficacy. Overall, the majority of traditionally delivered interventions in the preschool age group have not demonstrated positive outcomes in physical activity and it has been suggested that interventions targeting both children and their parents should be further explored (Ling, Robbins, Wen, & Peng, 2015).

c) Screen-time

There were no significant differences for screen-time outcomes between the intervention and comparison groups. There was, however, a significant change in weekday screen-time in the comparison group at 3-months and in the intervention group at 6-months.

Few similar studies have focused on screen-time behavior and there have been mixed results. One eHealth study in younger children (Wald et al., 2018) and two in older children found no significant changes (Paineau et al., 2008; Wright et al., 2013). Knowlden et al (2018) reported an improvement in screen-time in both groups in their web-based intervention, so perhaps a minimal intervention could be sufficient to action improvements in screen-time behaviors in preschool-aged children.

While barriers to screen-time were not specifically explored in this thesis, previous research has reported that parents can be reluctant to restrict their child's screen-time. Parents report using screen-time as an 'electronic baby-sitter' to do daily tasks such as cooking and cleaning and may also feel that screens are a 'safe' alternative to other activities at times when they are busy with such tasks and not able to provide direct supervision (Carson, Clark, Berry, Holt, & Latimer-Cheung, 2014). Parents also report that children have a high interest in screens, to the extent that when screen-time is taken away, they fear that a tantrum will result (Carson et al., 2014). Parent use of screens has been reported to be high, which makes it difficult for parents to apply restrictions to their children (Carson et al., 2014). Previous research has reported that parent concern regarding screen-time is not high because they regard it to be important for learning (Carson et al., 2014; De Decker et al., 2012; Hesketh, Hinkley, & Campbell, 2012). While the content of the *Time2bHealthy* study sought to address some of these issues, future studies may achieve better results through more targeted activities.

Proxy-reporting of screen-time by parents may not have been accurate in this study as research has indicated that parents tend to under-report screen-time (Reilly et al., 2008). Parents may have difficulty recalling small amounts of screen-time throughout the day, such as in the car, hanging washing out, cooking dinner, cleaning, while on the telephone etc. However, proxy-report measures have been used in many previous studies (Carson & Kuzik, 2017; Jago, Wood, Zahra, Thompson, & Sebire, 2015; Kesten et al., 2015; Nikken & Schols, 2015; Pyper, Harrington, & Manson, 2016) and the questions used to elicit screen-time estimates were based on a reliable tool used in previous studies (Downing, Hinkley, & Hesketh, 2015; Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012).

d) Sleep

There were no significant differences for sleep outcomes between the intervention and comparison groups. However, it must be noted that night-time accelerometry compliance was sub-optimal and was poorer than daytime compliance (See Chapter 4). No other similar eHealth study to the best of the author's knowledge has yet assessed sleep outcomes. However, one traditionally delivered study reported significant improvements in parent-reported sleep duration (Haines et al., 2013). As sleep is an emerging area in childhood obesity research and the importance of 24-hour movement behaviors are being recognized through research and newly established guidelines internationally (Australian Government Department of Health and Ageing, 2017; Tremblay et al., 2017), further research is required to accurately measure sleep in children. Polysomnography, which is the gold-standard for sleep measurement is time-consuming, costly and would also have been impractical for use in this study. Both accelerometry and subjective parent-reported measures of sleep were used in this study, a strategy recommended in a recent study, due to the low correlation between parent-reported sleep and accelerometer-measured sleep (Duraccio, Carbine, Barnett, Stevens & Jensen 2018). Objective sleep measurement was hampered in this study by the low night-time compliance rate and it is suggested that future studies explore strategies to improve night-time accelerometry compliance, such as trialing wrist-worn monitors (Fairclough et al., 2016), and providing incentives or reminders (Tudor-Locke et al., 2015).

1.2 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on parental role-modelling and parental self-efficacy in the above behaviors?

There was a significant group by time interaction for parent self-efficacy (nutrition), but no significant differences between the intervention and comparison groups for parent self-efficacy in relation to physical activity, screen-time or sleep nor parental role-modelling (See Chapter 4). There were, however, significant changes in parental role-modelling at 6-months in both groups.

The reasons for positive outcomes achieved for parent self-efficacy (nutrition) and not for the other behaviors are unclear, but it may be due to the higher proportion of program time dedicated to healthy eating and nutrition (two modules compared to only one module for the other behaviors) and the larger number of videos and activities, providing a greater opportunity for vicarious learning.

Backwards intervention mapping was used to design this study to align the target behaviors and intervention activities to Social Cognitive Theory of which self-efficacy is a key component. Parent self-efficacy is crucial for implementing obesity-related behavior change in children (Bohman, Ghaderi, & Rasmussen, 2013). Positive relationships have been reported between high parental (or maternal) self-efficacy and fruit and vegetable intake (Campbell, Hesketh, Silverii, & Abbott, 2010; Koh et al., 2014; Rohde et al., 2018) and MVPA (Rohde et al., 2018) and an inverse relationship with consumption of unhealthy food (Bohman, Rasmussen, & Ghaderi, 2016; Campbell et al., 2010; Jago, Sebire, Edwards, & Thompson, 2013; Rohde et al., 2018). Although Social Cognitive Theory has been used as a basis for similar studies (Baranowski et al., 2003; Wright et al., 2013), parent self-efficacy has rarely been assessed, despite this being key in parent-focused interventions. Knowlden et al (2017) reported significant changes in maternal physical activity and screen-time self-efficacy in the intervention group, but no difference between groups in their web-based intervention for mothers of preschool-aged children.

Parental role modelling has a profound effect on the obesity-related behaviors of their children, including physical activity (Hutchens & Lee, 2018; Mattocks et al., 2008), healthy mealtimes, food choices, preferences, patterns and practices (Birch, Savage, &

Ventura, 2007; Ostbye et al., 2013; Yee, Lwin, & Ho, 2017), TV viewing and other screen media use (Paudel, Leavy, & Jancey, 2016; Salmon, Tremblay, Marshall, & Hume, 2011). No other parent-focused eHealth study targeting childhood obesity or obesity-related behaviors to the best of the author's knowledge has assessed parental role modelling. Two traditionally delivered studies conducted in preschool-aged children found no significant improvement in parental modelling (Haire-Joshu et al., 2008; McGarvey et al., 2004).

1.3 What is the efficacy of the *Time2bHealthy* online lifestyle behavior change program on parent child feeding beliefs and practices?

There was a significant group by time interaction for 'pressure to eat' child feeding practices, but there was no significant difference between groups for 'restriction' of child feeding practices (See Chapter 4). Despite the body of evidence regarding child feeding practices and risk of overweight and obesity, there are limited studies which have used child feeding as an outcome measure. No other eHealth study to the best of the author's knowledge has assessed child feeding practices, so the outcomes of this study will be compared to traditionally delivered programs in preschool-aged children. Similar to this study, a significant improvement in 'pressure to eat' child feeding practices was reported in a group which received a regular newsletter (compared to a group which received a single booklet), but no significant changes in other child feeding practices were reported in a study of mothers of African American preschool-aged children (Essery, DiMarco, Rich, & Nichols, 2008). Conversely, Harvey-Berino et al (2003) found a significant reduction in 'restriction' child feeding practices, but not in other child feeding practices in their childhood obesity prevention study in Native-American preschool children which was delivered in the home (Harvey-Berino & Rourke, 2003). There have also been mixed outcomes in studies in older children. Burrows et al (2011) found a significant reduction in ‘pressure to eat’ child feeding practices across all groups in their three-arm childhood obesity intervention for 5- to 7-year-old children (consisting of a dietary intervention, physical activity intervention or both). There was also a significant reduction in ‘restriction’ child feeding practices in the dietary arm. Holland et al (2014) found a significant reduction in ‘restriction’ child feeding practices in their family-based intervention for 7-11-year-old children, but no significant change in ‘pressure to eat’ child feeding practices (Holland et al., 2014). As most studies have reported significant change in only one child feeding practice, it is possible that in this study as well as others, parents may find it difficult to focus on changing more than one of the practices simultaneously.

Previous research indicates that habit formation takes an average of nine-and-a-half weeks and can take up to as much as eight-and-a-half months (Lally, van Jaarsveld, Potts, & Wardle, 2009). Given that the length of the program was 11 weeks, it may have been difficult for parents to change behavior within this timeframe, particularly given that the target age group is known to be a peak time for food fussiness and refusal (de Barse et al., 2015; Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007) and practices may therefore have been more difficult to establish.

1.4 Was the intervention effect on BMI change mediated by changes in obesity-related variables or moderated by baseline participant characteristics?

As reported in Chapter 5, there were no significant effects found for the hypothesized mediators and moderators of BMI change in this study. Although the BMI main outcome analysis found no significant difference between groups in BMI change, it was nevertheless important to explore potential moderators and mediators for a number of reasons. First, it is possible for an intervention to have a greater indirect effect than direct effect on an outcome variable due to the effect on a mediator variable (Yildirim et al., 2013). In a situation where there is no significant effect on the main outcome, but a significant mediation effect, mediation analyses can reveal the potential for an intervention to influence the main outcome (MacKinnon, 2011). In relation to moderating factors, it is possible that there can be opposing effects of an intervention based on participant characteristics, meaning that the intervention can be effective for participants with certain characteristics and not others. Therefore, moderation analyses can be useful in situations where there is no significant result for the main outcome, as opposing effects of the intervention can determined that would not otherwise have been identified (MacKinnon, 2011).

The importance of exploring mediator and moderators of change in childhood obesity interventions has been highlighted in the literature (Whittemore, Chao, Popick, & Grey, 2013; Wilfley et al., 2007). However, less than 10 studies to date have explored the mediating and moderating factors of an intervention on change in BMI (Annesi, Walsh, Greenwood, Mareno, & Unruh-Rewkowski, 2017; Burke et al., 2017; Epstein, Paluch, Beecher, & Roemmich, 2008; Epstein et al., 2012; Epstein, Roemmich, et al., 2008; Lubans, Morgan, & Callister, 2012; White et al., 2004; Wilfley et al., 2007; Yildirim et al., 2013), with only two such studies assessing both (Epstein, Roemmich, et al., 2008; White et al., 2004) and of these, only one was in the preschool-age group (Epstein, Roemmich, et al., 2008). Mediators of BMI change have been assessed in only one eHealth childhood obesity intervention (White et al., 2004) and no previous eHealth studies, to the best of the author's knowledge, have assessed moderators. Due to the gradually increasing number of eHealth childhood obesity interventions and their mixed results, it is important to gain a better understanding of the mechanisms by which these interventions work and which participants they work for.

As previously mentioned, there may have been a dilution effect on BMI as most children in the study were a healthy weight. As well as potentially affecting the main outcome findings, it could also have affected the mediation and moderation results. It is also possible that there were other moderators and mediators that facilitated BMI change that were not measured in the study. There is only one other childhood obesity eHealth intervention which has assessed mediators of BMI change. This intervention delivered nutrition education and behavior change strategies to 11-15-year-old children and their parents and it was found that parent life and family satisfaction were significant mediators of weight loss (White et al., 2004).

There were mixed results in the only two traditionally delivered (i.e., face-to-face) childhood obesity studies that have been conducted in preschool age groups exploring mediators and/or moderators (Enö Persson, Bohman, Tynelius, Rasmussen, & Ghaderi, 2017; Epstein, Roemmich, et al., 2008). In a study targeting television viewing and computer use, socioeconomic status was a moderating factor, and targeted sedentary behavior was a mediator of *z*-score change (Epstein, Roemmich, et al., 2008). Unlike *Time2bHealthy*, the Epstein, Roemmich et al (2008) intervention was conducted over a much longer period of time (two years) and focused on solely on sedentary behavior. There were also imposed television viewing restrictions (using a specially fitted device) and incentives provided to the child participants to reduce screen use. The length of the intervention may have been a factor in the detection of significant results and had a longer follow-up period been included for *Time2bHealthy*, it may be possible that mediators could have been found. Given that *Time2bHealthy* focused on multiple obesity-related behaviors, it is also possible that the effect on any single behavior may have been diluted.

Previous studies in older children reported significant mediating and moderating factors of BMI change that were not collected in this study. These included mediating factors such as self-regulation, mood, child self-efficacy (Annesi et al., 2017), aerobic fitness (Maddison et al., 2012), resistance training self-efficacy, physical activity behavioral change (Lubans et al., 2012) and family factors (White et al., 2004) and moderating factors such as social adjustment/problems (Burke et al., 2017; Wilfley, Stein, Saelens, & et al., 2007), anxiety (Burke et al., 2017), built environment factors (Epstein et al., 2012), baseline energy dense food intake, parent concern over own weight, and parent child acceptance (Epstein, Paluch, et al., 2008). It is recommended that future trials explore the effects of a wide range of BMI mediators and moderators to allow for easier comparison between studies. The varied findings of studies which have explored mediators and moderators of BMI change in childhood obesity interventions to date highlight the need for more intervention studies, particularly those in young children and those delivered through an eHealth medium.

1.5 Did participants who highly engaged in the Facebook discussion group achieve superior outcomes to participants with a lower level of engagement?

There was no significant difference in BMI change between the participants who highly engaged in the Facebook discussion group compared to participants who had a lower level of engagement (see Chapter 6). These null findings are consistent with the null findings reported for the main outcomes, thus are probably due to most of the children in the study being in the healthy weight range and the sample being underpowered. Only three childhood obesity studies with a social media component have been conducted which have assessed BMI/BMI *z*-score change. These studies have been in infants (Downing, Campbell, van der Pligt, & Hesketh, 2017), preschool-aged children (Ling et al., 2018) and adolescents (Ruotsalainen, Kyngas, Tammelin, Heikkinen, & Kaariainen, 2015), with none reporting a significant BMI/BMI *z*-score outcome. Social media interventions have been shown to have potential in reducing BMI, based on the findings of a meta-analysis in adults which found a BMI reduction of one point (An, Ji, & Zhang, 2017). Similar to the study by Downing et al (2017), the *Time2bHealthy* study was not a standalone social media intervention, but rather an eHealth intervention where the main component was an online program and Facebook was utilized as a minor component with only basic functionality to facilitate a discussion group. There is the potential to use more advanced functions of Facebook groups (or other social media), which could be explored in future studies to enhance participant engagement and offer more opportunities for vicarious learning.

Significant differences in percentage sedentary time and sleep duration between children of parents who highly engaged in Facebook compared to those who had a lower engagement level were reported. A relatively high number of posts from participants were observed for these modules (i.e., sedentary time and sleep) and therefore the significant findings may be a result of participants obtaining vicarious learning (Bandura, 1986) through exposure to experiences and ideas of other participants in the Facebook group. This vicarious learning may not have occurred through the website as it may have for other modules as there was only one video for the sleep and screen-time modules, whereas other modules contained three or more.

A significant group by time interaction in the non-hypothesized direction in regard to kJ/kg was reported (i.e., parents who had lower engagement in the Facebook discussion group had children with lower kJ intake per kilogram of body weight). Although there is uncertainty of the reason for this finding, it may be possible that parents who had difficulty reducing their child's energy intake sought additional assistance through the Facebook group. It should also be noted that, due to limited resources, the 24-hour recall (on which this kJ measurement was calculated) was based on a single weekday's intake and was therefore probably not an ideal method to assess overall eating patterns. We found no significant differences in screen-time, child feeding, parental role-modelling or parent self-efficacy between the two levels of Facebook engagement. It appears that Facebook group engagement had a unique effect on outcomes as the findings from these analyses vary distinctly from the main outcome findings.

The evaluation of the Facebook component of this study was somewhat limited. In the analyses, participants were classified into only two groups: ‘low engagement’ and ‘high engagement’ due to the small number of participants analyzed. It is difficult to unequivocally determine if the participants with a high engagement level achieved positive outcomes due to the effect of the Facebook component, or that they were highly engaged in the Facebook group because they were already motivated, an issue highlighted in a previous eHealth study (Estabrooks et al., 2009). Future studies should explore different study designs, such as random allocation to a social media group or comparison group to more accurately compare the effects, and collection of qualitative data through interviews or focus groups.

Participant membership of the Facebook groups was high and most participants engaged with their assigned group on at least one occasion, comparable to similar studies (Downing et al., 2017; Swindle, Ward, & Whiteside-Mansell, 2018). Engagement differed depending on the module and cohort, which has also been reported in similar studies (Downing et al., 2017; Swindle et al., 2018). More comments per group member were generally observed in larger groups and it was apparent that a minimum number of participants were needed to generate ample discussion. Members of smaller groups may have been hesitant to ask a question or share an issue when there were no other posts, whereas in larger groups, where there were more posts or comments, participants may have felt more comfortable sharing information. Posts which featured more comments sometimes took the discussion in a slightly different direction and resulted in a variety of comments which could have prompted more participants to join the discussion. Level of interest in different modules varied and Facebook engagement tended to wane over the duration of the program, which generally corresponded to engagement in the overall program. Program non-completers either neglected joining the Facebook group or tended to have low or declining engagement in the Facebook group throughout the program. The fact that participation in Facebook discussion was not mandatory may have affected engagement levels. Declining engagement has also been reported in similar eHealth interventions (Baranowski et al., 2003; Wald et al., 2018; Williamson et al., 2006). For behavior change to occur, engagement needs to be maintained over a sustained period as habits take an average of 9.5 weeks to form (Lally et al., 2009). Future studies should therefore explore additional strategies to maintain participant engagement. This study, similar to others, used incentives to encourage participants to attend follow-up data collection. This resulted in a high retention rate (91%), but not all participants who attended the data collection appointments completed the online program nor actively participated in the Facebook group. One Facebook post per module was chosen to receive a gift card and perhaps more participants would have posted if they all received a gift card for each module that they posted. Available resources meant that this was not possible for this study, but this could be explored in future research.

The recruitment procedures and sole Internet delivery medium used in this study meant that participants generally did not know each other. The evidence is inconsistent regarding whether participant familiarity is beneficial to the outcomes of studies which have a social media component. A high level of engagement was found in a study of new Mums using ‘snowballing’ recruitment where participants were encouraged to invite friends to join (Kernot, Olds, Lewis, & Maher, 2014), so targeting existing friendship groups could be an effective engagement strategy. Confidentiality may however be a concern and some previous studies have reported that participants are more likely to share information with people that they do not know (Haslam, Tee, & Baker, 2017).

It has been suggested that interventions incorporate platforms that people are already familiar with (Hamm et al., 2014). The current popularity, familiarity, ease of use, accessibility and increasing number of parenting groups on Facebook were factors which were considered in deciding to use this platform for the intervention. Despite these positive attributes, some participants did experience some problems, such as forgetting email addresses used to sign up to Facebook (which was needed to ‘invite’ them to join the group). This issue was resolved by asking participants to access their other email accounts or updating their email address in Facebook settings. Technical issues have also been reported in similar studies (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004; Welch et al., 2018). Recent posts did not always appear first, as earlier posts with a high number of comments sometimes appeared first, which could have affected engagement if participants had to search for the most recent post.

7.4 Significance of the research

Childhood obesity has reached critical levels, both in Australia and world-wide (Australia Bureau of Statistics, 2015; Ng et al., 2014). The WHO has recommended that multi-sectorial approaches are required to address the issue (World Health Organization, 2017). Parents are a key influence on the development of obesity-related behaviors given that children are highly influenced by the family unit. Parental influence is particularly prominent in early childhood, where the foundations for healthy lifestyle behaviors are established. This stage is critically important as once behaviors are formed, they are inherently difficult to change. It is recognized that parent involvement in childhood obesity interventions is pivotal and interventions involving parents have resulted in superior outcomes to those that have not involved parents (Golan & Crow, 2004; Golan, Fainaru, & Weizman, 1998; Niemeier, Hektner, & Enger, 2012). At the early childhood stage, parent involvement is even more critical (Ho et al., 2012; Luttikhuis et al., 2009), but research in this age group has been lacking compared to older age groups (Luttikhuis et al., 2009). It has been reported that the home-based setting appears to be one of the most effective for children five years and younger (Ho et al., 2012; Luttikhuis et al., 2009; Nguyen, Kornman, & Baur, 2011; Waters et al., 2011) and it has been suggested that studies in this age group investigate the use of the eHealth delivery mode (Laws et al., 2014). eHealth interventions offer many advantages over traditionally delivered interventions for busy families such as convenience, flexibility and accessibility and with a large proportion of households connected to the Internet (86% in Australia in 2016-17 (Australian Bureau of Statistics, 2018) and similar access rates in other countries (Office for National Statistics, 2018; Pew Research Center, 2018)), and as such programs can be accessed by participants regardless of their location. Past eHealth-based childhood obesity interventions have demonstrated some positive improvements in dietary intake and physical activity (Chen et al., 2011; Paineau et al., 2008; Williamson et al., 2005; Williamson et al., 2006).

They also have the potential for broad-reach and the ability to overcome barriers of many traditionally delivered programs such as travel, time, scheduling of appointments and cost (Fitch et al., 2013; Grimes-Robison & Evans, 2008; Warren et al., 2007). Previous reviews have highlighted the lack of eHealth childhood obesity interventions in early childhood, a key stage for the establishment of healthy behaviors and parental influence, a gap that this doctoral research has addressed (An, Hayman, Park, Dusaj, & Ayres, 2009; Nguyen et al., 2011).

7.5 Contribution to knowledge

This study makes an important contribution to the literature on eHealth interventions for the prevention and/or treatment of childhood obesity where parents are the agent of change. Evidence presented in Chapter 2 indicated that some past eHealth childhood obesity treatment and prevention interventions have resulted in positive changes in obesity-related outcomes and have promising potential. However, to the best of the author's knowledge, only 10 RCTs have been conducted which have assessed the efficacy of a parent-focused childhood obesity eHealth intervention on BMI or BMI *z*-score and only two of these have been in the preschool age group, where parents are the main influence on child behaviors. One additional study has been conducted in preschool-aged children which used fat mass index as the adiposity outcome measurement (Nystrom et al., 2017). To the best of the author's knowledge, *Time2bHealthy* is the first RCT to assess the efficacy of a parent-focused eHealth childhood obesity intervention on BMI in preschool-aged children where eHealth is the sole delivery medium. Given that this is the first study of its kind, it contributes to the current literature, addressing a number of the current gaps within the field and paving the way for future effective interventions.

7.6 Strengths and limitations

There are a number of strengths of this research. The systematic review and meta-analysis were conducted using a registered study protocol, adherence to the PRISMA statement and a pre-determined search strategy which was applied to several databases to ensure that the search was comprehensive. This review was the first to quantitatively measure the effects of parent-focused eHealth childhood or adolescent obesity interventions on BMI or BMI *z*-score and has been updated to include studies up to June 2018. The *Time2bHealthy* RCT addressed several gaps in the literature: it was an intervention of high methodological quality, included a follow-up period and was solely delivered using eHealth strategies. It is the first study of its kind to be conducted in children under the age of 5 years. Objective and valid data collection methods were used where possible. Multiple obesity-related behaviors were targeted in the intervention, including healthy eating, physical activity, screen-time and sleep. No similar interventions to date have included such a wide range of behaviors. The study design was thoroughly planned, using backwards intervention mapping to align the target behaviors and intervention activities to Social Cognitive Theory. There was a high retention rate (>90%) and participants reported a high rate of acceptance of the mode of delivery, content and format of the program. Potential mediating and moderating factors of intervention effects were explored, and this is the first study of its kind to investigate the effect on an intervention of both mediating and moderating factors on BMI. This is also one of very few parent-focused childhood obesity studies to explore the effect of a social media component on BMI change.

There are a number of limitations to this research. First, there was a higher than expected proportion of children in the healthy weight range in the RCT, which meant that the effect of the intervention on BMI were likely diluted across the main analyses, the mediator and moderator analyses and Facebook engagement analyses. A sub-analysis of children in the overweight and obese range was not possible due to the small number of children in this group. Despite strategies to maximize participant recruitment, the target sample size was not reached and therefore statistical power would have been compromised. A longer follow-up period along with a larger sample may have been required to detect differences between groups. Self-reported data (such as questionnaires and a 24-hour dietary recall) were used for some secondary outcomes measures and it is possible for such data to be misreported (Gemming, Jiang, Swinburn, Utter, & Mhurchu, 2014; Poslusna, Ruprich, de Vries, Jakubikova, & van't Veer, 2009). However, this would likely occur across both groups given that participants were randomly allocated. This scenario is common across many studies assessing behavioral outcomes (Gemming et al., 2014; Poslusna et al., 2009). The measures used were the best available specific to the age group at the time of the study which were within the budget and timeframe required for the research to be conducted. The mediation and moderation exploratory analyses were limited by the range of factors that data were collected on. Facebook was used as a basic discussion forum as the intent of this component was to supplement the main intervention rather than a focal point. True social media interventions utilize a number of different aspects of social media which were beyond the scope of this study. Participants were categorized into low and high Facebook engagement, but it was not possible to determine if participants obtained a benefit from simply viewing the posts and comments rather than actively participating in discussions.

7.7 Recommendations for future research

1. **Larger sample size and longer follow-up**

As previously discussed, despite several novel and extensive strategies to maximize recruitment such as extending the recruitment period and expanding the recruitment area, the target sample size was not achieved, which likely compromised the power of the study. It is therefore suggested that future eHealth childhood obesity studies allocate adequate resources and time for recruitment and plan effective recruitment strategies which engage all relevant stakeholders at an early stage and assign adequate funding for promotional resources, including online/social media marketing to maximize recruitment.

Due to the extension of the recruitment period and the finite time to complete this research, the planned 12-month follow-up time-point could not be completed. A significant reduction in BMI was found in the intervention group at the 3- and 6-month time-points. If the planned follow-up period at 12-months had occurred as intended, it may have been long enough to detect a difference between groups. Of the 10 studies included in the literature review, only two included a follow-up period, and only one of these was 12-months or longer. Therefore, it is recommended that future studies allow ample time and resources to plan for a longer follow-up period to detect long-term change.

2. **Integration and reporting of theory**

In designing this study, an intervention mapping process was used to align each of the target behaviors and intervention activities to Social Cognitive Theory and this process was reported in detail in Chapter 3. However, the use and integration of behavior change theory has been poorly reported in similar previous studies. It is recommended that future studies also provide sufficient detail on integration of theory into interventions to allow for replication and comparison between studies.

3. **Application in rural areas**

There is greater need for childhood obesity interventions in rural areas due to higher incidence of overweight and obesity and less availability of services (National Health and Medical Research Council of Australia, 2013). *Time2bHealthy* has the potential for broad reach and applicability in rural areas. Only one parent-focused eHealth childhood obesity intervention has been conducted in a rural area to date. It is therefore recommended that future studies consider recruiting participants in rural areas.

4. **Exploration of social media components**

Due to the dearth of similar studies which have included a social media component and the promising results from this trial, which used social media at a very basic level, it is recommended that future studies explore the use of social media. It has been recommended that interventions incorporate social media platforms that people already use (Hamm et al., 2014), so it is imperative that researchers keep abreast of the latest and upcoming trends in this rapidly changing space. It is also recommended that any social media component that is employed should involve the use of a professional facilitator (Niela-Vilén, Axelin, Salanterä, & Melender, 2014) due to the risk of participants spreading misinformation (Welch et al., 2018; Westberg, Stavros, Smith, Munro, & Argus, 2018).

5. Further studies exploring mediating and moderating factors

To date, there are mixed results from previous studies which have explored mediating and moderating factors of childhood obesity interventions on BMI and therefore it is recommended that more studies are conducted, in particular those which include younger children and eHealth-based studies. The mediation and moderation exploratory analyses of this study were limited by the number of variables collected from participants. Past studies have included a disparate range of factors making it difficult to compare these factors between studies. It is therefore recommended that researchers review the existing literature and consider collecting a wider range of possible mediating and moderating factors to allow for comparison between studies and identification of significant mediating and moderating factors common across interventions.

6. Cost effectiveness analysis

Due to resource constraints, the *Time2bHealthy* RCT did not include a cost-effectiveness analysis, nor did any of the 10 studies identified in the literature review. It has been reported that the potential cost-effectiveness of childhood obesity prevention could be substantial, and with the generally low cost of eHealth programs per person, it is recommended that future studies include analyses to quantify cost-effectiveness.

7. Translational research

To the best of the author’s knowledge, no translational research studies have been conducted on parent-focused eHealth childhood obesity interventions. Translational research is important to determine if efficacious interventions can be applied in a real-world setting, where there may be different or accentuated challenges such as time constraints and work commitments of potential participants, as well as competing priorities of stakeholders, program sustainability, recruitment and retention (Croyden et al., 2018; Lucas et al., 2014; Welsby et al., 2014). It is therefore recommended that translational research be conducted with studies which have demonstrated efficacy in obesity-related behavior outcomes, such as *Time2bHealth*y, to determine effectiveness in real-world settings. Please refer to the Post-Script which provides details of a wide-scale translational research project that has recently been funded to fill this gap (May et al., 2018).

7.8 Conclusion

This doctoral research commenced with a systematic review and meta-analysis to identify gaps in the literature in regard to parent-focused eHealth childhood obesity interventions assessing BMI change. These gaps were then used to guide the development of the *Time2bHealthy* intervention. To the best of the author’s knowledge, *Time2bHealthy* is the first RCT to assess the efficacy of a parent-focused healthy lifestyle intervention on BMI in preschool-aged children which is delivered entirely online. There was no significant difference between groups in BMI change, however it is possible that this was due to the majority of participants being in the healthy weight range and insufficient power of the sample. The intervention did, however, result in significant improvements in frequency of discretionary food intake, parent self-efficacy (nutrition) and ‘pressure to eat’ child feeding practices. Despite these significant findings, the exploratory analyses of the mediators and moderators of the intervention on BMI found null results. This is the first study to investigate both moderators and mediators in eHealth interventions. Additionally, this is one of the first parent-focused childhood obesity studies including a social media component which have assessed the effect on BMI. The analyses of the Facebook component found no significant results in regard to BMI, however, children of parents who highly engaged in the Facebook group achieved significantly better outcomes for sedentary behavior and sleep compared to those with a lower level of engagement. Ambiguous results were found for kJ/kg of energy intake, whereby those children whose parents highly engaged in the Facebook group had a significant increase in energy intake compared to those who had a lower level of engagement. Although no improvement was found for BMI, the *Time2bHealthy* program has demonstrated promising results in improving some childhood obesity-related behaviors and has the potential for scalability and wide reach. It is recommended that future research include a larger sample and longer follow-up period. Future studies should also aim to recruit participants in rural areas, where access to childhood obesity services are typically limited. It is also important that future studies include cost-effective analyses. The integration of theory into interventions should be adequately planned and reported to allow for comparison and replication. It is recommended that future studies further explore the use of social media in interventions. Further research is also required to explore a wider range of possible mediating and moderating factors to gain greater insight into the mechanisms by which interventions achieve or don't achieve outcomes, which can be used to better inform the design of more successful interventions. Finally, there is a lack of translational research in eHealth childhood obesity studies and childhood obesity research in general. Translational research is crucial to further advance efficacious interventions and determine effectiveness in scaling these interventions into a real-world setting.

7.9 Post-script

Prior to the submission of this thesis, a translational research grant was awarded by the NSW Government to New South Wales Health, a consortium of five local health districts in urban, regional and rural areas of New South Wales and two universities – the University of Wollongong and the University of Newcastle. This project, which will commence later this year, will compare the effectiveness of three study arms; the *Time2bHealthy* program, a telephone-based healthy lifestyle parent support program (*Healthy Habits*), and a control condition.

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Appendix A

Statement of contribution of others

Megan Hammersley collaborated with her supervisors, Dr Rachel Jones and Professor Tony Okely to design and conduct this doctoral research on the *Time2bHealthy* online healthy lifestyle program. The candidate conducted the literature review and designed the intervention and RCT with the assistance of both supervisors. The candidate approached organisations and individuals to assist with recruitment (such as preschools, schools, general practices and early childhood health centres), fielded enquiries from potential participants, screened participants for eligibility, collected all baseline data, trained data collectors for follow-up data collection, cleaned, analysed and interpreted data (with the assistance of supervisors and a statistical consultant), and drafted and revised this thesis.

Megan L Hammersley

Rachel A Jones

Anthony D Okely

Author contributions

Published article from Chapter 2:

Hammersley, M.L., Jones, R.A., Okely, A.D. (2016). Parent-focused childhood and adolescent overweight and obesity eHealth interventions: A systematic review and meta-analysis. *Journal of Medical Internet Research* 18(7) e203. doi: 10.2196/jmir.5893

I attest that Megan Linda Hammersley contributed to the above paper. MLH registered the systematic review and meta-analysis with PROSPERO. MLH and RAJ screened and short-listed the articles to be included in the review by consensus. ADO reviewed articles where consensus could not be reached. MLH extracted data from the included studies. MLH and ADO independently assessed risk of bias. MLH conducted and interpreted the meta-analysis. MLH drafted and revised the manuscript. All authors reviewed and edited the manuscript and approved the final version.

Rachel A Jones	Anthony D Okely

Published article from Chapter 3:

Hammersley, M.L., Jones, R.A., Okely, A.D. (2017). *Time2bHealthy* – An online childhood obesity prevention program for preschool-aged children: A randomised controlled trial protocol. *Contemporary Clinical Trials*. 61:73-80. doi: 10.1016/j.cct.2017.07.022

I attest that Megan Linda Hammersley contributed to the above paper. MLH managed the day-to-day running of the study, managed data collection, contributed to study design, program content and drafted and edited the manuscript. RAJ contributed to the study design, program content and edited the manuscript. ADO contributed to study design, program content and edited the manuscript. All authors read and approved the final manuscript.

Rachel A Jones

Anthony D Okely

Submitted article from Chapter 4:

Hammersley, M.L., Okely, A.D., Batterham, M.J., Jones, R.A. *Time2bHealthy* – an internet-based childhood obesity prevention program for parents of preschool-aged children: outcomes of a randomized controlled trial. *Journal of Medical Internet Research* (under review).

I attest that Megan Linda Hammersley contributed to the above paper. MLH contributed to designing the research, conducted the research, analyzed data and wrote the paper. RAJ contributed to designing the research, conducted follow-up data collection and edited the manuscript. MJB contributed to designing the research, provided input and advice on the statistical analysis plan, data interpretation and edited the manuscript. ADO contributed to designing the research and edited the manuscript. All authors read and approved the final manuscript.

Rachel A Jones

Anthony D Okely

Marijka J Batterham

Submitted article from Chapter 5:

Hammersley, M.L., Okely, A.D., Batterham, M.J., Jones, R.A. Investigating the mediators and moderators of body mass index change in the *Time2bHealthy* childhood obesity prevention program for parents of preschool-aged children. *Childhood Obesity* (under review).

I attest that Megan Linda Hammersley contributed to the above paper. MLH contributed to designing the research, conducted the research, analyzed data and wrote the paper. RAJ contributed to designing the research, conducted the follow-up data collection and edited the manuscript. MJB contributed to designing the research, provided input and advice on the statistical analysis plan, data interpretation and edited the manuscript. ADO contributed to designing the research and edited the manuscript. All authors read and approved the final manuscript.

Rachel A Jones

Anthony D Okely

Marijka J Batterham

Submitted article from Chapter 6:

Hammersley, M.L., Okely, A.D., Batterham, M.J., Jones, R.A. Can parental engagement in social media enhance outcomes of an online healthy lifestyle program for preschool-aged children? *Journal of Communication* (under review).

I attest that Megan Linda Hammersley contributed to the above paper. MLH contributed to designing the research, conducted the research, analyzed data and wrote the paper. RAJ contributed to designing the research, conducted the follow-up data collection and edited the manuscript. MJB contributed to designing the research, provided input and advice on the statistical analysis plan, data interpretation and edited the manuscript. ADO contributed to designing the research and edited the manuscript. All authors read and approved the final manuscript.

Rachel A Jones

Anthony D Okely

Marijka J Batterham

Appendix B

Published article: Parent-focused childhood and adolescent overweight and obesity eHealth interventions: a systematic review and meta-analysis.

Hammersley, M.L., Jones, R.A., Okely, A.D. (2016). Parent-focused childhood and adolescent overweight and obesity eHealth interventions: A systematic review and meta-analysis. *Journal of Medical Internet Research* 18(7) e203. doi: 10.2196/jmir.5893

Original Paper

Parent-Focused Childhood and Adolescent Overweight and Obesity eHealth Interventions: A Systematic Review and Meta-Analysis

Megan L Hammersley, MSc; Rachel A Jones, PhD; Anthony D Okely, EdD

Early Start Research Institute, Faculty of Social Sciences, University of Wollongong, Wollongong, Australia

Corresponding Author:
Megan L Hammersley, MSc
Early Start Research Institute
Faculty of Social Sciences
University of Wollongong
Building 21
Northfields Ave
Wollongong, 2522
Australia
Phone: 61 403233875
Fax: 61 24221 3892
Email: megan.hammersley1@uowmail.edu.au

Abstract

Background: Effective broad-reach interventions to reduce childhood obesity are needed, but there is currently little consensus on the most effective approach. Parental involvement in interventions appears to be important. The use of eHealth modalities in interventions also seems to be promising. To our knowledge, there have been no previous reviews that have specifically investigated the effectiveness of parent-focused eHealth obesity interventions, a gap that this systematic review and meta-analysis intends to address.

Objective: The objective of this study was to review the evidence for body mass index (BMI)/BMI z-score improvements in eHealth overweight and obesity randomized controlled trials for children and adolescents, where parents or carers were an agent of change.

Methods: A systematic review and meta-analysis was conducted, which conforms to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement. Seven databases were searched for the period January 1995 to April 2015. Primary outcome measures were BMI and/or BMI z-score at baseline and post-intervention. Secondary outcomes included diet, physical activity, and screen time. Interventions were included if they targeted parents of children and adolescents aged 0-18 years of age and used an eHealth medium such as the Internet, interactive voice response (IVR), email, social media, telemedicine, or e-learning.

Results: Eight studies were included, involving 1487 parent and child or adolescent dyads. A total of 3 studies were obesity prevention trials, and 5 were obesity treatment trials. None of the studies found a statistically significant difference in BMI or BMI z-score between the intervention and control groups at post-intervention, and a meta-analysis demonstrated no significant difference in the effects of parent-focused eHealth obesity interventions compared with a control on BMI/BMI z-score (Standardized Mean Difference −0.15, 95% CI −0.45 to 0.16, Z=0.94, P=.35). Four of seven studies that reported on dietary outcomes demonstrated significant improvements in at least 1 dietary measurement, and 1 of 6 studies that reported on physical activity outcomes demonstrated significant improvements compared with the control. The quality of the interventions was generally not high; therefore, these results should be interpreted with caution.

Conclusion: It is recommended that larger, longer duration, high-quality parent-focused eHealth studies are conducted, which transform successful components from face-to-face interventions into an eHealth format and target younger age groups in particular.

Trial Registration: PROSPERO International Prospective Register of Systematic Reviews: CRD42015019837; http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015019837 (Archived by WebCite at http://www.webcitation.org/6ivBHvBhq)

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KEYWORDS

overweight; obesity; child; adolescent; internet; web; online; computer; IVR; telemedicine; healthy lifestyle; dietary intake; physical activity

Introduction

The escalating global challenge of childhood obesity has been well documented, with prevalence rates climbing to approximately 23% in developed countries and 13% in developing countries [1]. Childhood is a period of time where unhealthy behaviors such as consumption of energy-dense foods and beverages, physical inactivity, and sedentary behavior are established [2]. During this time, parental influence and role modeling play a key part in the development of such behaviors [3-5]. Parental involvement in childhood obesity interventions appears to be important, given that children are highly influenced by the family unit [6,7]. Recent systematic reviews and meta-analyses have investigated the effectiveness of parent-focused childhood obesity prevention and treatment interventions, with the weight of the evidence supporting the use of parent-focused interventions. A 2012 meta-analysis of weight-related behavior change interventions for 2- to 19-year olds where parents were involved resulted in greater body mass index (BMI) reductions than interventions that had optional or no parent involvement [4]. These are similar findings to 2 meta-analyses of children aged 5-12 years [8,9], whereas another meta-analysis of 2- to 18-year olds found that interventions that targeted parents had a smaller (yet still significant) effect than those that targeted children directly [10].

The lack of studies in preschool-aged children has been highlighted [11]. Of the aforementioned 2 meta-analyses that sought to include studies, which involved children from 2 years of age, one included no studies in the preschool age group and the other included only 2 studies in this age group [4,10]. A meta-analysis of parent-focused obesity prevention and treatment interventions specifically in the early childhood (0-6 years) age group demonstrated a small, yet significant combined effect in the short term, but in the long term, the combined results were not significant [2]. When the studies were looked at individually, 5 were successful in the long term, which were all commenced at preschool age. The baseline BMI of the children appeared to be a factor, as 2 of the 3 studies that were successful at both short- and long-term follow-up included only children who were overweight or obese [2].

Effective broad-reach interventions that target childhood are required; however, currently, there is little consensus on the most effective intervention approach [11]. As mentioned, interventions that target parents are effective [2,4,8]. In addition, the use of eHealth interventions also hold promise in this area, with the use of such technology in the child and adolescent age group having increased in recent years [12]. Two previous reviews have investigated the impact of technology-based overweight and obesity interventions in childhood and adolescence with some studies reporting changes in adiposity, dietary, and/or physical activity outcomes [12,13]. However, neither of these previous reviews have specifically investigated the effect of parent involvement.

This current systematic review and meta-analysis builds on previous reviews, but differs in that it is, to our knowledge, the first to measure the efficacy of eHealth interventions in improving BMI or BMI z-score in children and adolescents where parents are an agent of change. This review is of importance in determining effective broad-reach approaches to prevent and treat childhood obesity, which in the long term could potentially alter the path of childhood obesity and reduce the progression into adult life. The review adopts a broader definition of eHealth than 1 of the previous reviews and includes interventions using the Internet, IVR (computerized voice prompts over the telephone, which participants respond to via the telephone keypad), social media (Facebook, Twitter, and so forth), mobile health (such as mobile phone apps), telemedicine (using video conferencing), email, and e-learning. The objective of this current systematic review and meta-analysis was to determine whether eHealth childhood and adolescent overweight and obesity interventions, where parents or carers are the agents of change, improved BMI and/or BMI z-scores.

Methods

The protocol for this systematic review and meta-analysis was registered in advance with the PROSPERO international prospective register of systematic reviews (registration number CRD42015019837) and conforms to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [14].

Eligibility Criteria

Type of Studies

Randomized controlled trials investigating the effect of eHealth interventions on weight of children and adolescents, where parents or carers were an agent of change, were considered for this systematic review and meta-analysis. Studies were excluded if participants had special needs or had a condition where physical activity was restricted or if they required a special diet. Studies not published in English were also excluded.

Type of Participants

eHealth studies targeting obesity prevention or treatment for children and adolescents aged 0-18 years, where parents or carers were agents of change, were considered. The parent or carer being an agent of change was defined as the parent or carer having an active role in the intervention and being responsible for implementing change.

Types of Interventions

Interventions investigating the effect of eHealth on BMI were considered for inclusion. No restrictions were placed on the type of setting, provided that the parent or carer was an agent of change.

Types of Outcome Measures

Primary outcome measures were BMI and/or BMI z-score at baseline and post-intervention. Secondary outcomes included body fat, waist-to-hip ratio, and improvements to dietary intake, physical activity, sedentary behavior, screen time, biomedical indicators (such as blood pressure and cholesterol), knowledge, and self-efficacy.

Search Strategy

The electronic databases of A+ Education, CINAHL, ProQuest Central, PsycINFO, Scopus, SPORTDiscus, and Web of Science were searched with a limitation date of January 1995 to April 2015 using predetermined search terms (see Multimedia Appendix 1). Pre-1995 articles were not included as it was thought that any interventions at this early stage would be exceedingly basic. In addition, the reference lists of relevant articles were scanned.

Study Selection

After the database searches, 1 author (MH) removed duplicates and screened the titles of the articles, and relevant articles were shortlisted. A second author (RJ) then checked the decisions made. The abstracts of the remaining articles were then screened (by MH), and a second shortlist was derived and checked by a second author (RJ). The full text of the remaining articles was retrieved and read by author one to create a final shortlist. The shortlisted articles were then viewed by the second author (RJ). Any differences were discussed, and a decision was made by consensus. Where a decision could not be reached, a third author (AO) reviewed the papers to make a final decision.

Data Collection Process

One review author (MH) independently extracted the data from the included studies. Contact was made via email with the author of 1 paper to request additional data on BMI at a time point during the study, which was used in the meta-analysis and systematic review.

Risk of Bias in Individual Studies

Two reviewers (AO and MH) independently assessed risk of bias using a checklist adapted from the Consolidated Standards of Reporting Trials statement (see Table 1) [15]. In line with the recommendations of the PRISMA statement, each of the items on the checklist was evaluated separately rather than an overall score being assigned. Each item was given a + or − according to whether the item was described adequately in the article (+) or not adequately described or not present (−). Any differences were discussed, and a decision was made by consensus.

Table 1. Risk of bias checklist.

Item	Description
A	Key baseline characteristics are presented separately for treatment groups (age, gender, and body mass index—BMI), baseline outcomes were statistically tested, and results of tests were provided
B	Randomization procedure clearly and explicitly described and adequately carried out (generation of allocation sequence, allocation of concealment, and implementation)
C	Valid measurement of BMI (at minimum, standardized method used to measure height and weight and to calculate BMI are described)
D	Dropout described and ≤20% for <6-month follow-up or ≤30% for ≥6-month follow-up
E	Blinded outcome assessment (positive when those responsible for assessing BMI were blinded to the group allocation of individual participants)
F	Intention-to-treat analysis for BMI outcome(s) (participants analyzed in group they were originally allocated to and participants were not excluded from analyses because of noncompliance to treatment or because of missing data
G	Covariates accounted for in analyses (eg, baseline score, group or cluster, and other covariates when appropriate for age or gender)
H	Summary results for each group and adjusted scores presented (adjusted difference between groups and CI)
I	Power calculation reported, and the study was adequately powered to detect hypothesized relationships

Synthesis of Results

Extracted data were first described in a narrative manner. Studies that reported BMI or BMI z-score results as change scores or baseline and final values; standard deviation (SD), standard error (SE), or CIs; and the number of participants were included in a meta-analysis. Mean change was calculated where required, and SDs were calculated from SE or CI where SD was not reported [16]. Where the final SD value was missing, this value was imputed from baseline SD [16]. Missing SD change values were calculated using an imputed correlation coefficient [16].

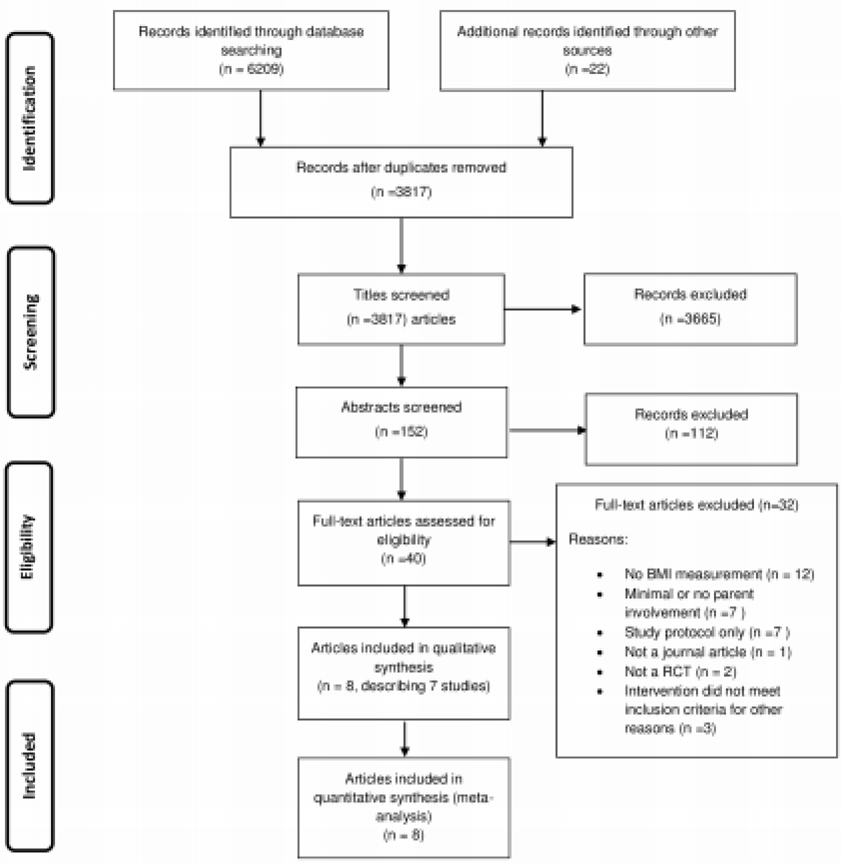
Where a study had 2 eHealth intervention arms, the number of participants in the control group was divided by 2 to ensure that participants were not counted more than once in the analysis. Heterogeneity was assessed via I2 index test. The meta-analysis was conducted with reported or calculated change scores for the data collection point closest to the end of the intervention. One study was reported across 2 articles [17,18], and the time points in both these articles were used (baseline to 6 months and 6 months to 2 years—which was calculated from the available data). To enable either BMI or BMI z-score to be included in the same meta-analysis, standardized mean difference (SMD) was used. Where a study reported both BMI and BMI z-score, BMI was used. One study involved a day camp before the implementation of the eHealth intervention, and therefore, the post-camp BMI measures were used as baseline measures for the purpose of the meta-analysis to isolate this component [19]. A random effects model was applied to the analysis given the heterogeneity across the studies [16]. Analysis was conducted using Review Manager (RevMan: computer program) version 5.3; Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Results

Study Selection

From the 3817 papers that were initially identified, 8 papers describing 7 separate studies met the inclusion criteria (Figure 1).

Figure 1. Study selection flow diagram.



Description of Studies

Table 2 outlines the characteristics of the studies meeting the inclusion criteria; 7 studies were conducted in the past 10 years, and only 1 study was conducted outside the United States (in France) [22]. There were a total 1487 dyads participating in the included 8 studies (range 35-1013 dyads). A range of cultural or ethnic groups participated in studies, including African American (with 3 studies including only African American participants [17-19]), Latino [20], Chinese American (1 study included only Chinese-American participants [21]), and French [22].In total, 5 studies were overweight or obesity treatment interventions [17,18,20,23,24] and 3 studies overweight prevention interventions [19,21,22]. The gender proportions of the child or adolescent participants were 47.21% male and 52.79% female. Two of the studies included only girls [17,18]. Parent gender was reported in only 1 study [24], where 96% were female. In total, 3 studies involved children (range 7-10 years) [19,22,23], 3 studies involved adolescents (range 11-15 years) [17,18,21], and 2 studies included both children and adolescents (range 5-12 years) [20,24]. The length of the interventions ranged from 8 weeks to 2 years, with 4 studies being ≤12 weeks [19-21,24], 3 studies being ≤8 months [17,22,23] and 1 study being 2 years in duration [18]. Only 1 study collected follow-up data to assess maintenance of changes in the months after the completion of the intervention [21]. Retention rates were reported in 7 studies, and the average retention rate was 80% ± 6.3 (ranging from 70% to 93%) [17,18,20-24].

Description of Interventions

Two of the studies had 3 study arms [20,22], and the remaining 6 studies had 2 study arms. Five studies used an Internet intervention [17-19,21,22], 2 used IVR [20,24], and 1 used telemedicine [23]. Of the Internet interventions, 1 used Internet only [21], and others used the Internet in combination with face-to-face counseling [17,18], telephone counseling, and nutrition lessons [22] or a camp [19]. The focus of behavior change differed between studies, with one focusing on diet, physical activity, and screen time [20]; 6 focusing on diet and physical activity [17-19,21-23] and 1 focusing on diet and screen time [24].

A theoretical framework underpinned 4 of the studies, 2 were underpinned by Social Cognitive Theory [19,24], 1 reported using a combination of trans-theoretical model and social cognitive theory [21], and 1 reported using social-ecological theory [20]. Studies varied in the level of detail that they provided regarding how the theory was used in the design of the intervention.

The level of parental involvement varied among studies. In 1 study, only the parents participated in the intervention (children were involved only at the data collection stages) [20]. In the remaining 7 studies, the parent and the child or adolescent both had active involvement in the intervention, either the child or adolescent participated in the eHealth activities with the parent together or there were separate components designed specifically for the parent and the child or adolescent [17-19,21-24].

Studies used differing measures of adiposity, with most using multiple measures. Six studies used BMI [17-19,21,22,24], 4 studies used BMI z-score [20,22-24], 4 studies used BMI percentile [17,18,23,24], 3 used body fat (measured by DEXA [17-19], and 1 study used waist-to-hip ratio [21]. Other measures included dietary intake (measured by food frequency questionnaire [17,18,20,24], 24-hour recall [17-19,23], or food records [21,22]) physical activity (measured by questionnaire [17-20,22] or accelerometer [19,21,23]), and screen time (measured by questionnaire [20,24]).

Three of the studies reported on the effect of higher usage of the interventions. One IVR study reported that participants who completed more calls significantly decreased their BMI z-score compared with the control group [20], whereas another IVR study reported that participants who were high IVR users demonstrated a significant reduction in BMI and BMI z-score compared with low IVR users [24]. One of the Internet studies [17] reported that change in percentage body fat was negatively correlated with use of an email facility to counselors, performance on quizzes, and use of an Internet weight monitoring function.

Risk of Bias Within Studies

Table 3 summarizes the results of the risk of bias assessment for all included studies. Of the 8 studies, 6 reported key baseline characteristics separately for each study arm, and the results of statistical tests were provided. Seven studies reported an acceptable dropout rate (≤20% for <6-month follow-up or ≤30% for ≥6-month follow-up), and the remaining study did not report dropout rates. Six studies used intention-to-treat analysis for BMI outcomes, 7 studies accounted for covariates in the analysis; power calculations were reported and adequate in 5 articles. Only two studies described an adequate randomization procedure and/or reported summary results for each group with adjusted scores, and none of the studies described a valid, standardized method of BMI measurement.

Table 2. Summary of parent-focused childhood or adolescent obesity eHealth interventions.

Author, Year, Country	Participants	Intervention description	Parental involvement	Behaviors targeted	Variables measured	Key findings
Baranowski et al 2003, USA [19]	n=35, 8 years of age, girls	4-week camp with specially designed activities, followed by 8-week behavior change Internet intervention. Control girls attended camp with usual activities and a monthly Internet program with general health information and homework.	No parent involvement in camp. Intervention, and control parents had access to a website, which covered similar topics to girls' website.	Diet (dietary fat intake, dietary fiber, water and satiety, SSB[a]), moderate to vigorous PA[b]	Demographics, body mass index (BMI), WC[c], physical maturation, body fat (DEXA), diet (2 ×24-hour recall), PA (accelerometer and qne), preferences for PA, and SSB.	For the Internet component, no significant changes to BMI were observed. No other variables were measured at the end of the camp, so the effect of the Internet intervention on variables other than BMI could be determined.
Chen et al 2011, USA [21]	n=54, 12-15 years of age Chinese American	Behavior change Internet program with goal setting tailored to stage of change. 8 ×weekly sessions for children. Control participants accessed a general health information Internet site.	Parents received 3 Internet sessions over 8 weeks to increase knowledge and skills.	Diet (food pyramid, meal planning, portion size), PA	Parent height and weight, child BMI, waist-to-hip ratio, blood pressure, PA (accelerometer), diet (3-day food diary), PA and nutrition knowledge (qne), dietary and PA self-efficacy.	Significantly more participants in the intervention reduced their waist-to-hip ratio than the control group (effect size= −0.01, P=.02). There were also significant increases in PA (effect size=12.46, P=.01), increases to F&V[d] intake (effect size=0.14, P=.001) and increased PA knowledge (effect size=0.16, P=.008), and nutrition knowledge (effect size=0.18, P=.001).
Davis et al 2013, USA [23]	n=58, 5-11 years of age, rural setting	8 × weekly telemedicine delivered psychoeducational sessions covering goal setting, diet and PA, plus 6 ×monthly sessions. Control participants visited their primary care physician to discuss set topics.	Parents met in a group separately, but at the same time as the children and covered similar content.	Nutrition (stoplight diet, portion sizes, food labels, vitamins and minerals, nutrient density), energy balance, PA, screen time, and SB[e].	Demographics, BMI z-score, diet (24-hour recall), PA (accelerometer), child behavior checklist, behavioral pediatrics feeding assessment scale.	No statistical difference in BMI z-score between groups. There was also no significant difference between groups for kilocalories or PA.
Estabrooks et al 2009, USA [20]	n=220, 8-12 years of age	Group A: 2 × 2-hour weekly group sessions on nutrition, PA, problem-solving, and action planning delivered by dietitian. Group B: attended group sessions plus 10 interactive voice response (IVR) follow-up sessions, involving goal-setting at end of call. Both the groups received a workbook with homework on nutrition and PA topics. Control group received workbook only.	Parent was main agent of change (children participated in data collection only)	Weight, nutrition, PA, and parenting skills.	BMI z-score, PA and SB (questionnaire—qne), F&V and SSB[a] consumption (qne), eating disorder symptoms (qne).	No significant difference in BMI z-score between groups. Significant increase in moderate-intensity physical activity in IVR group but no difference between groups. Participants completing 6-10 IVR calls significantly reduced BMI z-score compared with other groups [F(3,148)= −2.89, P<.01].

Author, Year, Country	Participants	Intervention description	Parental involvement	Behaviors targeted	Variables measured	Key findings
Paineau et al 2008, France [22]	n=1013, 7-9 years of age	All intervention families accessed a website containing information, interactive components, and other functionality. They received 30-minute dietary counseling telephone calls from a dietitian monthly for 8 months after Web-based completion of questionnaires. Children received 3 nutrition lessons at school. Children and parents received monthly newsletters. Group A: advised to reduce fat and increase complex cholesterol (CHO), Group B: advised to reduce fat and sugars and increase complex CHO. Control group received only general nutrition information at the same intervals.	Families accessed website and received mobile phone calls. Parents received monthly newsletter.	Nutrition (portions, frequency of eating, meal modification, and healthier alternatives)	Demographics, BMI, BMI z-score, body fat, WC, chest circumference, knee circumference, dietary intake (total energy, fats, sugars, complex CHO, protein) (Web-based qne and dietary records), PA (qne)	No significant difference between groups in regard to BMI or other anthropometric measures. Group A: Significantly increased complex CHO intake (mean change +10.1 (6.0-14.2) 95% CI, $P<.05$). Group B: Significantly reduced sugar intake (mean change −10.0 (−13.4 to −6.6) 95% CI, $P<.01$). Both groups A and B reduced total energy (mean change A −60 (−104 to −15) 95% CI, $P<.05$, B −96 (−146 to −45) 95% CI, $P<.01$) and fat intake (mean change A −8.2 (−10.6 to −5.8) 95% CI, $P<.01$, B −8.3 (−10.8 to −5.7), 95% CI, $P<.01$) compared with control group. No difference in PA between groups.
Williamson et al 2005, USA [17]	n=57, 11-15 years of age, African-American girls	Behavioral website providing nutrition information and behavior modification for 6 months. Counseling provided via email. Control group had access to general noninteractive health website. 4 face-to-face sessions over 12 weeks, focused on goal setting, behavioral contracting, monitoring of progress, and problem-solving. Control group sessions were conducted by a dietitian and included general nutrition information.	Parent and adolescent participated in the face-to-face and Internet components together	Nutrition (low energy diet, F&V, PA, food monitoring)	Demographics, BMI, BMI percentile, body fat (DEXA), eating disorders, pubertal status, dietary intake (24-hour recall and FFQ), weight loss behavior scale, child dietary self-efficacy scale, PA social support, children's eating attitudes test, satisfaction with life scale, child depression inventory, Rosenberg self-esteem scale, Kansas family life satisfaction scale, symptom checklist-90	Participants in the intervention group lost significantly more body fat (−1.12± 0.47 standard error—SE) than the control group 0.43±0.47 SE, $P<.05$) There was a significant difference in BMI change between groups (intervention −0.19 ± 0.24 SE, <0.05, control +0.65 ± 0.23 SE, $P<.05$). Participants in the intervention group significantly reduced fat intake compared with control group (FFQ) (−145.67 ± 37.67 SE, $P<.05$)
Williamson et al 2006, USA [18]	n=57, 11-15 years of age, African-American girls	Behavioral website providing nutrition information and behavior modification over 2 years. Counseling provided via email. Control group had access to general noninteractive health website. 4 face-to-face sessions over 12 weeks, focused on goal setting, behavioral contracting, monitoring of progress, and problem-solving. Control group sessions were conducted by a dietitian and included general nutrition information.	Parent and adolescent participated in the face-to-face and Internet components together	Nutrition (low energy diet, F&V, PA, food monitoring).	Demographics, BMI, BMI percentile, body fat (DEXA), eating disorders, pubertal status, weight loss behavior scale, website use, computer opinion survey.	At 2 years, there was no significant difference in BMI, weight, or body fat. Higher BMI percentile at baseline was associated with greater reduction in BMI percentile. Higher weight loss behavior scale score at baseline was associated with greater improvement. In regard to reported consumption of fattening foods, there was a significant difference between groups (F (1,48) =2.08, $P<.05$).

Author, Year, Country	Participants	Intervention description	Parental involvement	Behaviors targeted	Variables measured	Key findings
Wright et al 2013, USA [24]	n=50, 9-12 years of age	Parents and children individually received 12× weekly interactive voice response (IVR) telephone counseling calls, which provided education, monitoring, and counseling on managing weight and reducing screen time. Information sent via electronic health record to the child's pediatrician and used at visit 1 month after the intervention. Control participants attended the same pediatrician visit.	Received IVR calls independently to children.	Nutrition (energy, spotlight diet, healthy alternatives, cooking and shopping, eating out), and screen time	BMI, dietary intake (energy, fat, fruits, vegetables) (qne), TV viewing time (qne)	There was no significant difference between groups for BMI, BMI z-score, dietary intake or screen time. There was a significant difference in weight (−4.0 change, P=.001), BMI (−1.2 change, P=.01), and BMI z-score (−0.1 change, P=.04) between high users and low users.

[a]SSB: sugar-sweetened beverages.

[b]PA: physical activity.

[c]WC: waist circumference.

[d]F&V=fruit and vegetables.

[e]SB: sedentary behavior.

Table 3. Risk of bias assessment in randomized controlled trials assessing BMI outcomes of parent-focused eHealth overweight and obesity interventions.

Study	Baranowski et al 2003	Chen et al 2011	Davis et al 2013	Estabrooks et al 2009	Paineau et al 2008	Williamson et al 2005	Williamson et al 2006	Wright et al 2013
Baseline characteristics by group	+	−	+	+	+	+	−	+
Randomization described and conducted	+	−	−	−	−	−	−	+
Valid measurement of BMI	−	−	−	−	−	−	−	−
Dropout ≤20% for <6 months and ≤30% for ≥6 months	−	+	+	+	+	+	+	+
Blinded outcome assessment	−	−	−	−	+	−	−	−
Intention to treat for BMI outcomes	+	−	−	+	+	+	+	+
Covariates accounted for in analysis	+	−	+	+	+	+	+	+
Summary results + adjusted difference between groups + CI	+	+	−	−	−	−	−	−
Power calculation reported and power adequate	−	+	+	+	+	−	+	−

+ Adequately described and present.
− absent.

Results of Individual Studies

Adiposity Outcomes

None of the included studies reported a significant difference between groups for BMI, BMI z-score, BMI percentile, or percentage body fat from baseline to the end of the eHealth intervention. One study reported a significant difference in percentage body fat between groups at 6 months (−1.12 ± 0.47 SE, P<.05) [17]; this change was not maintained at the end of the 2-year intervention [18]. One study reported a significant difference between groups for waist-to-hip ratio from baseline to the end of the intervention (effect size = −0.01, P=.02) but reported no significant difference for BMI between groups [21].

Dietary Outcomes

Four of the seven studies that assessed dietary intake (which were all Internet interventions) demonstrated a significant difference between groups in regard to improvement in at least 1 dietary outcome, such as fruit and vegetable intake [21], nutrition knowledge [21], total energy intake [22], fat intake [17,22] and "eating less fattening foods" [18].

Physical Activity Outcomes

Of the 6 studies that assessed physical activity (which was an Internet intervention), 1 study demonstrated a significant difference between groups in objectively measured physical activity and physical activity knowledge [21].

Screen Time Outcomes

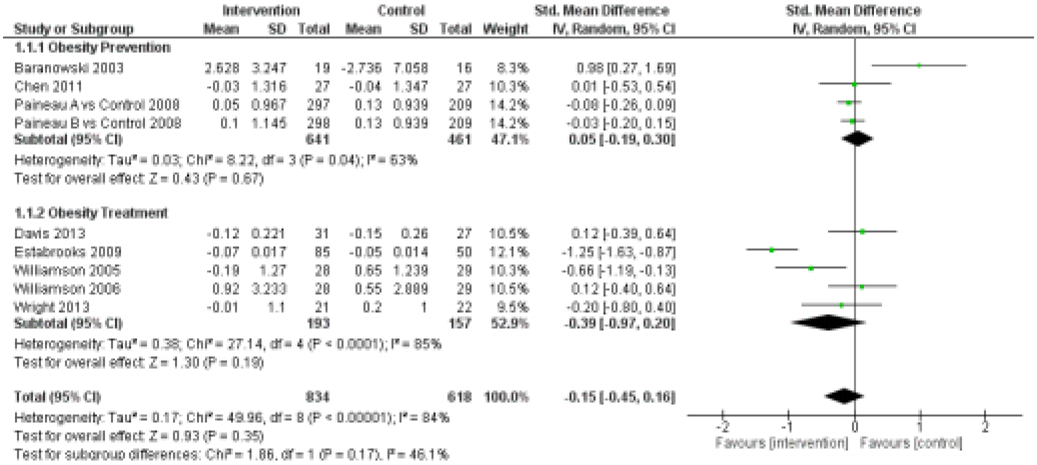
Neither of the 2 studies that assessed screen time demonstrated a significant difference between groups for screen time [22,24].

Synthesis of Results

A meta-analysis was conducted on pooled data from 8 papers with a total of 9 study arms, which compared eHealth intervention groups with control groups. The meta-analysis results are displayed in Figure 2. The studies were found to be significantly heterogeneous (I2=84%, 95% CI: 71%-91%, *P*<.001). There was no significant difference in the effects of the eHealth interventions compared with the control groups on BMI/BMI z-score (SMD −0.15, 95% CI: −0.45 to 0.16, *Z*=0.93, *P*=.35). A sensitivity analysis was conducted by removing an outlying study [19], with heterogeneity decreasing slightly (I2=83%, 95% CI: 67%-91%, *P*<.001) and although the standardized mean difference moved toward favoring the intervention (−0.25, 95% CI −0.55 to 0.05), significance was not reached (*Z*=1.63, *P*=.10).

A sub-group analysis was conducted based on whether the study aim was obesity treatment or obesity prevention (refer to Figure 2). There was a larger effect for the obesity treatment studies (−0.39, 95% CI −0.97 to 0.20) compared with the obesity prevention studies (0.05, 95% CI −0.19 to 0.30), although this was not statistically significant. The obesity treatment studies appeared to have a higher level of heterogeneity (85%) than the obesity prevention studies (63%); however, given the small number of studies included, this should be interpreted with caution.

Figure 2. Effect of eHealth interventions on BMI or BMI z-score.



Discussion

This meta-analysis and systematic review is, to our knowledge, the first to measure the effects of parent-focused eHealth childhood obesity interventions on BMI / BMI z-score. Overall, it was determined by meta-analysis that the included interventions did not result in significant improvements to BMI or BMI z-score compared with a control group. However, 4 of the 8 studies reported a significant improvement in at least 1 dietary or physical activity outcome measure.

The short duration of most of the studies may have meant there was insufficient time to detect changes in BMI or BMI z-score. The longest intervention demonstrated a significant improvement in body fat at the 6-month point [17], but this was not sustained at the end of the intervention at 2 years [18]. Maintenance of weight loss in the long term is indeed important but is a widespread challenge that has been well documented in both adult and child or adolescent age groups [11,25]. Previous parent-focused childhood or adolescent obesity systematic reviews and meta-analyses (which have not focused on eHealth) have highlighted the low proportion of studies, which have a follow-up period of >12 months [2-4,10,26], and 1 meta-analysis stated that there was a potential publication bias, meaning that it was suspected that some long-term follow-up studies with null results were not published [2]. Likewise, the lack of long-term follow-up studies has also been identified in childhood or adolescent obesity eHealth systematic reviews (which have not concentrated solely on parent-focused interventions), and it has been recommended that future interventions incorporate long-term follow-up in their design [12,13].

Maintaining engagement in eHealth interventions can be challenging [27]. The dropout rates in the current meta-analysis ranged from 12% to 29%. Previous childhood obesity eHealth systematic reviews have reported dropout rates up to 58% [12,13]. For participants that complete an eHealth intervention, the level of engagement as measured by usage rates can vary. Two of the studies in this review reported that higher usage rates resulted in more favorable BMI or BMI z-score outcomes [20,24], and 1 study found that body fat was negatively correlated to use of an email facility to counselors, quiz results, and weight self-monitoring [17]. Conversely, lower usage rates may therefore have impacted the effectiveness of the interventions in this review. The extent of such an effect is difficult to determine as the remaining studies did not report on the differential outcomes of high users compared with low users. It is also difficult to ascertain if those who use an intervention more do so because they are more motivated, and therefore, results of comparisons between high and low users may not necessarily be indicative of the effect of the intervention itself [20]. None of the previous eHealth or parent-focused childhood obesity systematic reviews have specifically addressed the effect of usage rates on outcomes; however, it has been demonstrated in a previous systematic review on general eHealth interventions that adhere to weight-related eHealth interventions are associated with positive outcomes [28].

Most of the studies in this current review used an eHealth modality combined with face-to-face, telephone, group sessions, workbooks, or camp activities [17-20,22-24]. Only one of the interventions used eHealth as the sole mode, and interestingly, this was the only intervention to demonstrate a significant difference between groups in an anthropometric measure at the end of the intervention, with participants in the intervention group achieving a significant reduction in waist-to-hip ratio compared with the control group [21]. In regard to the studies that used other modes in addition to the eHealth mode, in most cases, it was not possible to isolate the effects of the eHealth mode, and therefore, we were not able to determine the exact effect of the eHealth component. A previous parent-focused childhood obesity systematic review found that interventions where parents received only 1 delivery mode produced better outcomes than interventions with more than 1 mode of delivery. The authors speculated that the parents may have found the intervention to be too complex when more than 1 mode was used [2], and it is possible that this may have been the case for other studies included in this current review. Previous eHealth childhood or adolescent obesity systematic reviews have discussed isolating the effects of the eHealth intervention either only briefly or not at all. Nguyen found that of the 24 studies reviewed, only 6 used eHealth as the sole mode, and 4 of these 6 studies resulted in significant improvements in BMI, BMI z-score, or obesity-related behaviors [12].

The level of parent and child or adolescent involvement in the interventions varied, but 7 of the 8 interventions involved the children or adolescents to some degree [17-19,21-24]. Only 1 of the studies delivered the intervention solely to the parent [20]. Interestingly, this was the study that was found to have the largest effect size. However, due to the small number of studies included, it is difficult to draw any conclusions from this, particularly given that the result was not statistically significant. This is similar to findings from previous parent-focused childhood or adolescent obesity systematic reviews, most of which have found that parent-focused interventions have demonstrated better outcomes than interventions where there was either no parent involvement or it was optional [4,8,9].

Three of the studies in the current review were aimed at obesity prevention and did not have being overweight or obese as an inclusion criteria. Baseline BMI or BMI z-score was therefore lower in these studies than in studies where obesity treatment was the focus, and this may have been a factor in reporting nonsignificant findings for BMI outcomes. Understandably, a subgroup analysis indicated a larger effect for obesity treatment studies compared with obesity prevention studies, which confers with a previous parent-focused childhood obesity review, which found that interventions largely aimed at obesity prevention did not significantly reduce BMI but rather prevented increases in BMI [4]. However, both these types of studies (obesity prevention and treatment) are important.

The eHealth modality used may have been a factor in the success of an intervention; however, due to the small number of studies using particular eHealth modalities (only 1 used telemedicine and 2 used interactive voice response), a subgroup analysis was not conducted. The systematic review found that 4 of the 5 Internet interventions produced positive outcomes in waist-to-hip ratio, nutrition, or physical activity measures. Internet interventions are the widest studied of eHealth modalities and have demonstrated positive effects in other recent reviews on eHealth obesity interventions [12,29].

The effectiveness of the specific content of eHealth interventions on study outcomes has not been specifically addressed in previous eHealth childhood obesity systematic reviews. In adult populations, Internet interventions with additional components such as self-monitoring, feedback, reminders, email counseling, Web-based discussion groups, Web-based lessons, text messages, social networking, or mobile phone apps have been found to be more successful in producing weight loss outcomes. Such components were used to a small extent in the studies included in this review, including monitoring [18,21,22], email counseling [18], feedback [18], and reminders [19]. The incorporation of more of these components in future eHealth childhood obesity interventions may assist in improving outcomes.

There were no interventions targeting the early childhood age group (0-5 years) in this review, and in general childhood obesity research, there has been a lack of interventions in this age group [11]. Overall, parent-focused childhood obesity interventions have been found to be effective in this age group in the short term, particularly where only 1 mode of intervention is used [2]. It has been proposed that early childhood is the ideal life stage to intervene in the course of childhood obesity as it is a time where new healthy lifestyle practices can be introduced, rather than attempting to change well-established unhealthy practices in older age groups [5]. At this stage of life, parents are usually the main influence on the nutrition and physical activity practices of their children, and therefore, the effect of parental influence is likely to be more profound than in older age groups when outside influences become more prominent [5]. Engaging parents of young children via an eHealth modality may be an appealing format for parent-focused interventions, given that parents in developed countries with children within this age group appear to be tech savvy (as suggested by a high proportion of Internet or SMART phone use) [30-33].

There were only a small number of studies found over the 20-year period included in this meta-analysis, demonstrating that this field of study has not been well investigated, despite the dramatic advances and acceptability in technology. eHealth in childhood or adolescent obesity is only a relatively new area; a 2010 systematic review found only 21 studies, and only 11 of these were randomized controlled trials (RCTs) [12]. In this current parent-focused review, there was only 1 study found that was over 10 years old.

The quality of the interventions was generally not high, with the areas of randomization, blinded outcome assessment, valid measurement of BMI, and adjusted difference between groups either not being described or adequately carried out in a number of studies. The results should therefore be interpreted with caution due to potential bias. This is a similar finding to a previous eHealth childhood obesity review [12].

Strengths and Limitations

The strengths of this meta-analysis and systematic review include adherence to a registered study protocol and rigorous use of the PRISMA statement. A detailed search strategy was used over several databases with a wide date range, and strict inclusion criteria were applied during the study selection process. To our knowledge, this review is the first to quantitatively measure the effects of parent-focused eHealth childhood or adolescent obesity interventions on BMI or BMI z-score. Limitations of this review include the restriction to articles published only in English, the small number of RCTs found, varying study quality, heterogeneity of the studies, inadequate power to detect an outcome in some studies due to a small number of participants, inability to isolate the effects of the eHealth component of the intervention in most studies, varying aims between studies (with some studies focusing on obesity prevention and others on obesity treatment), and all but 1 study being conducted in the United States.

In regard to the meta-analysis, as previously stated in the results, there was an outlying study that favored the control group [19]. It should be noted that this study reported a significant difference in BMI measures at baseline (with the control group having a much larger mean BMI than the intervention group), which may have influenced the results. The planned subgroup analyses comparing the type of eHealth modality used and participant age were not conducted due to the small number of studies and the wide range of ages within the individual studies making it difficult to analyze different age groups. Finally, as there were less than 10 studies in the meta-analysis, a funnel plot analysis was not conducted due to the low power of this test when there are a small number of included studies [16].

Conclusions

This systematic review and meta-analysis found that there was no significant reduction in BMI or BMI z-score resulting from parent-focused eHealth childhood or adolescent obesity interventions compared with control. Only 1 study found a significant change in weight or adiposity measures (waist-to-hip ratio), and half of the studies demonstrated significant improvements obesity-related behaviors such as diet or physical activity compared with a control group. Only 1 study used eHealth as the sole modality, making it difficult to determine the true effect of eHealth on obesity. This review highlighted key weaknesses in the current literature: most studies were generally not of high quality, many had a short duration and lack of long-term follow-up, and many included only a small number of participants; and therefore, they may have been inadequately powered. There was an absence of studies that included children aged younger than 5 years, an age group where parental influence is probably more profound than older childhood and adolescence. It is therefore recommended that larger, high-quality studies of longer duration and longer follow-up are conducted, which transform successful components from face-to-face interventions into an eHealth format, particularly those that target younger age groups.

Conflicts of Interest

None declared

Multimedia Appendix 1

Search strategy.

[PDF File (Adobe PDF File), 19KB - jmir_v18i7e203_app1.pdf]

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Abbreviations

BMI: body mass index
BMI z-score: body mass index z-score
CHO: carbohydrate
CI: confidence interval
FFQ: food frequency questionnaire
F&V: fruit and vegetable
IVR: interactive voice response
PA: physical activity
Qne: questionnaire
RCTs: randomized controlled trials
SSB: sugar-sweetened beverages
SD: standard deviation
SE: standard error
SMD: Standardized mean difference
WC: waist circumference

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Appendix C

Published article: *Time2bHealthy* – an online childhood obesity prevention program for preschool-aged children: a randomised controlled trial protocol.

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Time2bHealthy – An online childhood obesity prevention program for preschool-aged children: A randomised controlled trial protocol

Megan L. Hammersley*, Rachel A. Jones, Anthony D. Okely

Early Start, Faculty of Social Sciences, University of Wollongong, NSW 2522, Australia

ARTICLE INFO

Keywords:
Childhood obesity
eHealth
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Parent

ABSTRACT

Background: The use of parent-focused internet-based programs for the prevention and treatment of childhood obesity has shown promise but there is an acknowledged gap in parent-focused interventions which target the early childhood stage.

Methods: The aim of this study is to determine the efficacy of *Time2bHealthy* - an online healthy lifestyle program for parents of preschool-aged children. The program will be evaluated using a two-arm, parallel, randomised controlled design. The 11-week program is underpinned by Social Cognitive Theory and consists of interactive modules on healthy eating, physical activity, screen-time and sleep. The intervention also involves elements of social media, where participants share discuss ideas and experiences and they can interact and obtain information with experts. *Time2bHealthy* is being compared to a comparison condition. Outcomes include change in BMI (primary outcome), dietary intake, physical activity, sleep, child feeding, parental role-modelling and parent self-efficacy. Process evaluation data, such as adherence and engagement with the online forums, will also be collected.

Discussion: *Time2bHealthy* is the first randomised controlled trial to our knowledge to assess the efficacy of an online parent-focussed healthy lifestyle program for preschool-aged children in changing body mass index. Early childhood is a crucial time for establishing healthy lifestyle behaviours and parents play an important role. This study therefore fills an important gap in the literature. If found to be efficacious, *Time2bHealthy* has potential for broad-reach access and translation into primary health care services.

Trial Registration: The study is registered with the Australian and New Zealand Clinical Trials Registry (12616000119493).

1. Introduction

Overweight and obesity in early childhood is associated with a range of short- and long-term health consequences. Furthermore, overweight children have at least twice the risk of remaining overweight into their adult life compared to children in the healthy weight range [1]. Effective weight management interventions can reduce the likelihood of childhood overweight and obesity continuing into adulthood. Increasing physical activity and improving eating behaviours are recognised cornerstone weight management strategies [1,2]. There is also increasing evidence regarding the importance of limiting screen-time [3], reducing sedentary activities [4–6] and maintaining healthy sleeping patterns [7–9].

Parental influence and role-modelling play a key part in the development of such behaviours [10–12]. Therefore, the role of parents in overweight and obesity prevention and intervention programs is critical. Previous reviews have highlighted the success of interventions which involve parents compared to those that do not [13–15]. This is particularly true for programs that target young children. Despite the importance of parental involvement in overweight and obesity prevention and treatment programs, there are recognised barriers such as scheduling of appointments/sessions [15], stigma, parental denial [16], childcare for other siblings [17], travel [18] and cost [15] that prevent parental involvement and potentially success of the programs.

The use of the online medium for overweight and obesity prevention and treatment programs offers advantages compared to face-to-face programs in convenience and accessibility. There have been an increasing number of online healthy lifestyle interventions for children in recent years. Systematic reviews have demonstrated that such interventions are efficacious in improving obesity-related behaviours and are cost effective, however the majority of studies have been conducted in the primary- or high-school age groups and most have not involved parents as an agent of change [19–21]. A recent meta-analysis of parent-focussed eHealth obesity interventions found that while there

* Corresponding author.
E-mail address: mlh965@uowmail.edu.au (M.L. Hammersley).

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was no significant effect found in BMI/BMI z-score change, half of the studies demonstrated significant improvements obesity-related behaviours such as diet or physical activity compared to a control group. In this review there was an absence of studies which included children under the age of five years, an age group where parental influence is probably more profound than older childhood and adolescence [12]. It was therefore recommended that larger, high quality studies are conducted which transform successful components from face-to-face interventions into an eHealth format, particularly those which target younger age groups and focus on parents as agents of change [19]. The aim of this paper is to describe the protocol for the *Time2bHealthy* study. The purpose of the study is to determine the efficacy of the parent-focused *Time2bHealthy* online program in facilitating behaviour change among preschool-aged children who are overweight, or at risk of becoming overweight. The primary hypothesis is that children in the intervention group will demonstrate significantly greater reductions in BMI/BMI z-score compared to the comparison group by the 6-month follow-up. Secondary outcomes including child dietary intake, physical activity, screen-time, sleep and parent self-efficacy will also be assessed.

2. Methods

2.1. Study design

The *Time2bHealthy* study is a two-arm randomised controlled trial involving parent-child dyads (Fig. 1). *Time2bHealthy* is based on formative research with parents of preschool-aged children. This research analysed the content of 300 publicly available websites containing healthy lifestyle information for children of preschool age and found that the websites lacked strategies on how to practically apply the information and set goals to assist in changing behaviours. Focus group results from this research similarly indicated that parents would find information of how to implement changes helpful. Parents also advised that an online program would need to be easy to use and be flexible and highly credible. Personalised feedback from a health professional was also important to parents [22].

Based on the results of this research, a 10-week, five-module online program – *Time2bHealthy* – was developed which covered the areas of healthy meals, healthy snacks and drinks, physical activity and screen-time. The program was piloted with 47 dyads and was found to be

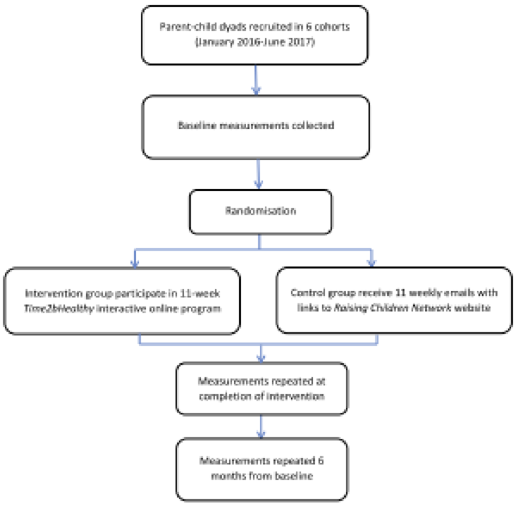

Fig. 1. *Time2bHealthy* study design.

acceptable, potentially efficacious and had a high level of retention [23] and a randomised controlled trial is now required to fully test the efficacy of the intervention. Due to more recent research into the effects of sleep on overweight and obesity in children, an additional module on sleep was added to the program for the current trial. Content of the modules was also updated according to the latest evidence-based recommendations [24–26] and the behaviour change and goal-setting aspects of the program were strengthened.

The study will be reported according to the Consolidated Standards of Reporting Trials (CONSORT) statement [27]. The study has been approved by the University of Wollongong Human Research Ethics Committee (HE15/354) and is registered with the Australian and New Zealand Clinical Trials Registry (12616000119493).

2.2. Participant recruitment and eligibility criteria

Participants are being recruited from the Illawarra, Southern and South-Western Sydney, Southern Highlands and Shoalhaven areas of New South Wales and Melbourne, Victoria. To assist with recruitment, organisations and individuals such as early childhood education centres, schools, playgroups, general practices, early childhood nurses, preschool swimming and sporting activities are being contacted and asked to distribute flyers and/or display posters. Articles have been placed in university and local health district newsletters, a Facebook page was created to communicate information about the study throughout the recruitment areas and a media release was sent to media agencies.

Potential participants are provided with a participant information sheet and screened for eligibility via phone or email. Participants are eligible if they live in one of the geographical areas described, the child is 2–5 years of age and not yet attending school at the time of recruitment and the child is at or above the WHO 50th percentile for body mass index for their age and sex. Parents are also required to have a Facebook account or be willing to create one for the duration of the study.

Child participants are excluded if they are taking medications or have a medical condition that can affect weight. As such, children are excluded if they are taking any of the following medications: Ritalin or other therapy for attention deficit hyperactivity disorder, long-term steroids, anti-psychotic medication. Furthermore, children are excluded if they have any of the following conditions or disabilities; Prader-Willi Syndrome, Bardet-Biedl Syndrome, Diabetes, Phenylketonuria or other metabolic disorders, Cystic Fibrosis, significant physical or developmental disability (that restricts age-appropriate play) or other conditions associated with overweight/obesity. Children with conditions such as Coeliac Disease or food allergies are able to participate, but parents are informed that some of the healthy eating content of the program will not be entirely appropriate and they will need make their own modifications to some of the information provided to suit their child's specific dietary requirements.

Eligible participants provide informed consent after reading the participant information sheet by completing a written consent form. Eligibility is confirmed at the baseline data collection visit when child height and weight are measured and body mass index is calculated to determine if the child is at or above the WHO 50th percentile for age and sex. Recruitment commenced in January 2016, with participants being recruited into six cohorts on a rolling basis. It is anticipated that recruitment will be completed by June 2017.

2.3. Power and sample size

We expect an effect size of approximately 0.4 for this trial (based on the results of the pilot study). To detect a statistically significant difference between groups (alpha = 0.05 and power = 0.8), 136 participants are required (68 per group) and considering an estimated attrition rate of 15%, 160 participants are planned to be recruited (80 per group).

2.4. Randomisation

Once participants are recruited and baseline measures are collected for each cohort, participants are randomised into the intervention or comparison group. Randomisation is conducted by a data manager using a concealed computerised random number generator. The data manager is not involved in the recruitment or delivery of the intervention. Results of the randomisation are then communicated to the researcher responsible for implementing the intervention. Height, weight, physical activity, dietary intake, sleep, screen-time, parental modelling and self-efficacy are assessed at baseline, post-intervention and 6-month follow-up. Baseline data collection is completed prior to randomisation, so data collectors are blinded to group allocation. At post-intervention and 6-month follow-up data collection time-points accelerometers are fitted and questions on dietary intake, sleep, screen-time, role-modelling and parent self-efficacy are entered directly into an iPad by the participants. Height and weight measurements at the follow-up time-points are taken by data collectors who are blinded to group allocation.

2.5. Theoretical framework

The intervention is guided by Bandura's Social Cognitive Theory, which proposes that there are three influences on behaviour: personal, behavioural and environmental (which is also known as reciprocal determinism) [28]. The interaction of the personal, environmental and behavioural influences within the *Time2bHealthy* intervention is illustrated in Fig. 2.

- Personal influence refers to an individual's self-efficacy (or their personal belief in their ability) to carry out a behaviour. This will be based on their personality, knowledge, beliefs, self-perceptions and expectations. Knowledge and beliefs of the importance of healthy eating, physical activity, sleep and limiting screen-time for preschool-aged children are addressed through the program content of the modules.
- Environmental influence refers to supportive environments which assist an individual to carry out a behaviour. An individual will be influenced by physical and societal influences in the environment. Videos demonstrating effective use of skills and behaviours by others will provide participants with vicarious learning. Communication, feedback and reinforcement from other participants via the Facebook group and from research staff via individualised communication also assists in supporting participants in practising the skills and behaviours.
- Behavioural influence refers to the response by the individual once they have practised carrying out a behaviour. This experience will determine how often and how well they will carry out a behaviour. After setting SMART goals specific, measureable, achievable, realistic and time-framed) [29] and action plans, participants will practice the skills and behaviours. Positive reinforcement will be gained through the monitoring of progress with their goals and action plans and the personal benefits experienced.

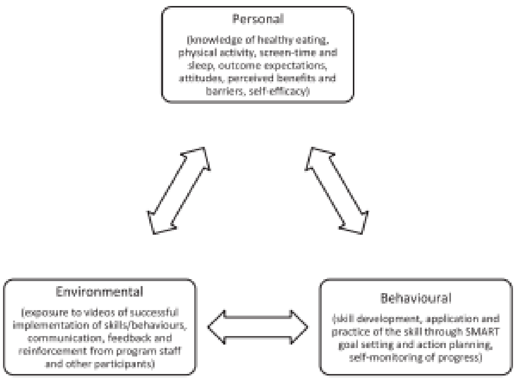

Fig. 2. Personal, environmental and behavioural influences within the *Time2bHealthy* program.

The intervention addresses the four key processes of Social Cognitive Theory for learning and adapting new behaviours: attention, retention, production and motivation [28]. Attention is addressed by ensuring that the website is easy to use and contains interactive evidence-based components (videos, activities and goal-setting), so participants are engaged. Retention is supported through an optimal length for the program, interaction with other participants through the closed Facebook group and quizzes to support parents in remembering the key content from each module. Production is addressed through goal-setting, action planning, addressing barriers and behaviour rehearsal. Motivation is addressed through creating cognitive dissonance by parents documenting current behaviours (e.g. in the activity planner) and asking parents to identify the positive outcomes and expectations as a result of performing the planned actions. Throughout the goal-setting process, parents are asked their motivation to make a change and SMART goals [29] are set, where parents are asked to aim challenging, yet realistic goals.

2.6. Intervention development

A backwards intervention mapping process was utilised in designing the study to align the *Time2bHealthy* intervention activities to the theory and target behaviours (developed by Robinson [30,31]). This process involved determining the overall goal first and then working backwards to identify the major and sub-categories, the target behaviours needed to achieve these and strategies based around the elements of Social Cognitive Theory that can be applied to support the theory. Fig. 3 illustrates this process for the physical activity component of the intervention.

Table 1 outlines the components of each of the modules of the *Time2bHealthy* online program. The content is based on evidence-based guidelines and recommendations for dietary intake, physical activity, screen-time and sleep.

2.7. *Time2bHealthy* intervention

Time2bHealthy consists of 6 modules on topics including nutrition ($n = 2$), physical activity, screen-time and sleep and is delivered over a period of 11 weeks. Each module takes approximately 30 min to complete and modules are completed over a two-week period. The modules involve participants reading text on each topic, watching videos, completing activities and setting goals. Goal-setting and subsequent revision of goals has been demonstrated to be important in the success of lifestyle behaviour change interventions [32,33,23]. Feedback is provided by a dietitian via the website regarding the goals set, with advice provided to enhance the goals in line with the SMART goal framework [29]. Additionally, participants receive regular emails to remind them to log on to the website, aimed to assist with participant retention. A closed (secret) Facebook group is accessible, where participants have the opportunity to communicate with other members of the cohort as well as the dietitian. The Facebook group is regularly monitored and moderated by the dietitian to ensure that the information discussed is consistent with evidence-based guidelines. Participants are asked to provide regular input to these groups by sharing healthy

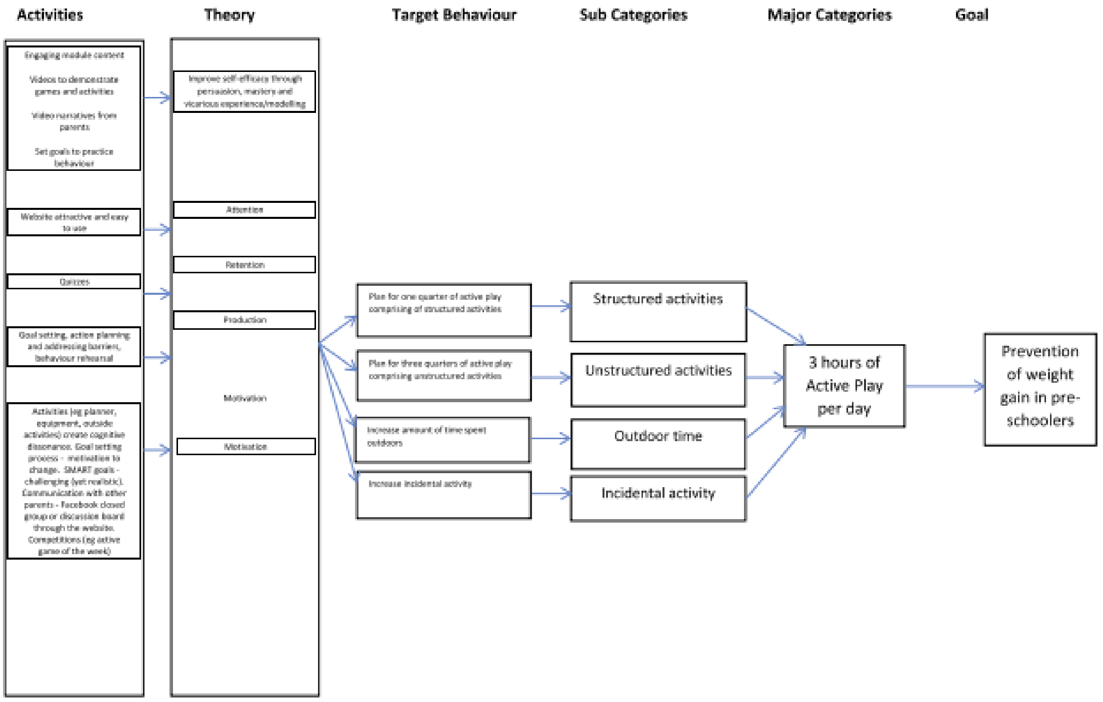

Fig. 3. Backwards intervention mapping process used in the development of the physical activity module.

recipes/photos of meals, healthy snacks, suitable physical activities and personal ideas and experiences in regard to reducing screen-time and improving sleep. Incentives (either shopping gift cards or vouchers to a children's museum) are provided in return for the time taken for participants to contribute this input.

At the end of the online program at 11-weeks, participants continue to receive fortnightly contact via email. These emails contain infographics which provide a summary of the content from the online program and direct participants to visit the online program to review material and their progress with goals set.

2.8. *Comparison condition*

Participants assigned to the comparison group receive fortnightly emails directing them to various topics on the evidence-based, Australian government-funded parenting website: *Raising Children Network*. The topics provided are of a similar nature to the intervention group (nutrition, physical activity, screen-time and sleep) and other general health topics relevant to the preschool life stage. The comparison group does not have access to any interactive components such as practical activities, goal setting, and individualised feedback.

Table 1
Components of the *Time2bHealthy* Online Program.

Module	Module content	Guidelines informing content
Module 1 – Introduction	General overview including goal-setting, Information on support from dietitian, Information on Facebook group and link, Timetable for program, Weekly planner.	
Module 2 – Healthy Meals	Introduction to healthy eating, How much food?, Serving sizes, Decreasing sugar consumption, How to read labels, Decreasing saturated fat consumption, Increasing fruit and vegetable consumption, Recipe modification, Getting the balance right, Goal-setting.	Australian Dietary Guidelines [24]
Module 3 – Healthy Snacks and Drinks	Why healthy snacks and drinks?, Which snacks and drinks?, What snacks and drinks are consumed in your house?, Healthy snacks and drinks, Choosing snacks and drinks, Goal review, Goal-setting.	Australian Dietary Guidelines [24]
Module 4 – Physical Activity	What is physical activity?, Why do physical activity?, What physical activity is happening now?, How to increase physical activity, Space, Equipment, Creative outside activities, When to increase physical activity, Goal review, Goal-setting.	Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (0–5 years) [25]
Module 5 – Screen-time	What is small screen recreation and how much?, why 1 h?, How much small screen recreation is happening now?, Too much small screen recreation?, If not small screen recreation then what?, Let their imagination run wild, Active small screen recreation, When can you decrease small screen recreation? Goal review, Goal-setting.	Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (0–5 years) [25]
Module 6 – Sleep	About sleep, What are my child's sleeping patterns now? How long my children should be sleeping for? What can I do?, Persistence with resistance, Improving sleep time, Goal review, Goal-setting	National Sleep Foundation Sleep Time Duration Recommendations [26]

Table 2
Outcome measures collected.

Outcome measure	Method	Baseline	Post-intervention	6-month follow-up
Child				
Weight status[a]	Body mass index	√	√	√
Physical activity	Accelerometer	√	√	√
Child (reported by parent)				
Dietary Intake	Questionnaire [42] and 24-hour recall completed via Easy Diet Diary app	√	√	√
Sleep	Accelerometer and questionnaire [37]	√	√	√
Screen-time	Questionnaire [44,45]	√	√	√
Demographics	Questionnaire	√		
Parent				
Self-efficacy	Questionnaire [48]	√	√	√
Parental role-modelling	Modified questionnaire [46,47]	√	√	√
Child feeding	Modified questionnaire [43]	√	√	√
Demographics	Questionnaire	√		

[a] Primary outcome measure.

Additionally, the comparison group is also offered access to the *Time2bHealthy* program at the completion of the follow-up data collection; however, due to time constraints participants will not have access to the Facebook group or receive the regular email contact when they have access to the *Time2bHealthy* program.

2.9. Outcome measures

All measures are collected via face-to-face appointments at the University of Wollongong Early Start building, the participant's home or a community setting, where both parent and child attend. All questionnaires are completed by parents using an iPad. Appointments are approximately 30–45 min in duration. The outcome measures collected are described in Table 2.

2.10. Primary outcome measure

Body Mass Index is calculated with height and weight measurements. Height and weight are measured using a standardised method [2]. Height is measured to the nearest 0.1 mm using a stadiometer. Weight is measured to the nearest 0.1 kg using a SECA scale. Height and weight are measured twice and recorded. An average of the two measurements is then used for BMI calculations. In instances where height measurements differ more than 0.5 cm and weight measurements differ more than 0.5 kg, a third measurement is taken.

2.11. Secondary outcome measures

2.11.1. Physical activity

Actigraph GT3X+ accelerometer (ActiGraph Corporation, Pensacola, FL) are used to measure the intensity and amount of physical activity that is occurring over time. The Actigraph GT3X+ accelerometer is a small, light-weight device which records tri-axial movement (up and down, side to side and forward and backward). Accelerometers have been extensively used in physical activity studies in children and they have been validated for use in the preschool age-group [2].

Accelerometers collect very high-frequency raw data (30 Hz) on activity counts, which are stored as epochs in the device and then downloaded for analysis. Cut-points to differentiate physical activity intensity that are appropriate for the preschool age-group will be utilised in the analysis [34,35].

All child participants wear an Actigraph accelerometer around the waist on an elasticised belt continuously for a period of seven days (for 24 h per day), removing them only for a bath/shower or water activities. The accelerometers are fitted to participants at the time of the face-to-face appointments and they are collected from the participant's home or participants return them in a reply paid envelope. Parents are provided with instructions on how to remove and re-fit the device.

2.11.2. Sleep

Accelerometers will be used to assess sleep habits in conjunction with a questionnaire [36]. A number of recent studies have utilised accelerometers in children for a 24-hour period to assess both sleep and physical activity [37–40].

The questionnaire used consists of eight questions and has been modified from a tool which has been previously validated in the preschool age group (Children's Sleep Habits Questionnaire [36]) and includes questions about typical bedtime and wake up time, typical time and duration of daytime nap and other sleep habits. The information from this questionnaire will be utilised in conjunction with accelerometer data to determine sleep duration.

2.11.3. Dietary intake

Two methods are used to assess dietary intake. Parents firstly complete four multi-component questions which have been modified from a parent-reported questionnaire which has been validated in the preschool age group (The Eating and Physical Activity Questionnaire (EPAQ)) [41]. The second method is a 24-hour recall of the previous day's dietary intake. Parents enter this information into the 'Easy Diet Diary' app (Xyris Software (Australia) Pty Ltd) on an iPad.

2.11.4. Child feeding

The questionnaire consists of 12 questions from the validated Child Feeding Questionnaire [42] and asks parents about their attitudes, beliefs and practices regarding child feeding.

2.11.5. Screen-time

This questionnaire asks parents to estimate the usual amount of screen-time for their child on a typical weekday and weekend day to determine average screen-time per week. Questions are also included about the availability of screens and rules about screen entertainment. The questions are based on a questionnaire previously assessed for reliability [43,44].

2.11.6. Parental modelling

Parents are asked about parental modelling of the behaviours addressed in the intervention (nutrition, physical activity, screen-time and sleep). As there is not an appropriate validated tool in the existing literature, these four questions have been developed after reviewing other parent-modelling questionnaires such as the Parental Modelling of Eating Behaviours Scale [45] and the Home Environment Survey [46].

2.11.7. Parent self-efficacy

Parents are asked about their self-efficacy relating to their child's nutrition, physical activity, screen-time and sleep. This questionnaire consists of 13 questions and has been modified from a previously validated questionnaire [47].

2.11.8. Demographic characteristics

Demographic information is collected from the parents via an iPad. Variables include participant child age, child sex, child DOB, parent age, parent sex, parent height and weight, Aboriginal or Torres Strait Islander status, language spoken at home, postcode, where they found out about the study, child care/preschool attendance, number of children in household, number of adults in household, marital status, highest level of education, family income, relationship to child, birth weight, premature birth and duration of breastfeeding. This information is collected at the baseline time-point only.

2.11.9. Process evaluation

Process evaluation is being conducted via a questionnaire which participants are asked to complete at the end of the online program. Participants are asked to complete a series of questions with responses on a Likert scale. Specifically, participants are asked about program content, if the content was interesting, easy to understand, relevant and appropriate. They are asked about the length of the program and duration of the modules, the goal-setting component and feedback received from the dietitian. Participants are asked if they completed the modules in one sitting or at different times and how much time they spent to complete each module. They are asked about the online delivery of the program and if they would have preferred a different format. They are also asked about the Facebook component of the program.

2.12. Statistical analysis

The outcomes will be assessed by comparing the differences in change over time between the intervention and comparison groups. Linear mixed or generalised linear mixed models will be used to analyse the data to determine differences between groups over time (baseline, 12 weeks and 6 months) with adjustment for potential covariates (see below).

Intention-to-treat principles will be used, with all participants analysed in the group which they are randomised. Covariates will include age, and accelerometer wear time.

Two types of exploratory analyses will be conducted to examine the theoretical assumptions of the intervention. First, hypothesised mediators of change in BMI (child physical activity, screen- time, eating behaviours, sleep, self-efficacy, parental role-modelling) will be examined using the PROCESS SPSS Macro version 2.16. Potential moderators of the intervention effects (e.g., child age and sex) will also be explored using the PROCESS SPSS Macro version 2.16 [48].

Relationships between demographic data and outcome variables will also be considered.

2.13. Discussion

This paper describes the *Time2bHealthy* study – the first randomised controlled trial to our knowledge to assess the efficacy of an online parent-focussed healthy lifestyle program for preschool-aged children in changing body mass index. This study therefore fills a gap in the literature and addresses many limitations in similar studies conducted in older age groups, such as risk of bias, small sample size, lack of follow-up and parents not being the agents of change in most studies [19].

The study has a number of strengths, including a planned sample size that has been calculated to ensure adequate statistical power. Objective and valid data collection methods are being used for outcome measures. A 6-month follow-up will determine if the changes made during the intervention can be maintained. The mode of delivery that is being used for the study has demonstrated the potential to be effective. Multiple obesity-related behaviours including healthy eating, physical activity, screen-time and sleep are targeted in the intervention. Finally, the intervention has been designed in line with Social Cognitive Theory using an established backwards intervention mapping process.

There are however some risks and limitations. The study design includes children who have a healthy weight and it is therefore possible that the BMI changes may be diluted. As the comparison group also receives information on similar topics, it is possible that behaviour change may occur in both groups. Due to the use of self-reported data for some measures, there is the potential for parents to intentionally or unintentionally misreport, however, this is an issue that is common to all free-living studies assessing behavioural measures such as dietary intake. There is limited opportunity to establish rapport with participants (compared to face-to-face or telephone-based interventions). Initial rapport will be established during the initial face-to-face data collection appointment. A community will also be established online through the closed Facebook group to facilitate communication and building rapport with and between participants.

This study will make an important contribution to the literature on internet interventions for the prevention and/or treatment of childhood obesity where parents are the agent of change. Evidence indicates that carefully targeted internet childhood obesity treatment and prevention programs have promising potential and the internet is a mode of delivery which has been shown to offer specific appeal to the target group [22,23]. A large proportion of Australian households are connected to the internet (83% in 2012–2013), including those in regional, rural and remote areas [49], potentially enabling widespread access to programs regardless of geographic location. The intervention also has the potential for broad reach as it negates many barriers associated with traditional delivery methods [15–18].

If found to be efficacious, the *Time2bHealthy* study has potential for translation into primary health care services, in particular for parents in rural and remote areas, where access to obesity prevention and management services can be limited and overweight and obesity prevalence is higher [2].

Ethics approval and consent to participate

The study protocol has been approved by the University of Wollongong Human Research Ethics Committee (HE15/354). Participants provide informed written consent before participating.

Consent for publication

Not applicable.

Availability of data and material

The datasets from this study are available from the corresponding author on written request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MLH is a PhD student and managed the day-to-day running of the study, managed data collection, contributed to study design, program content and drafted and edited the manuscript. RAJ is PhD supervisor to MH and contributed to the study design, program content and edited the manuscript. ADO is PhD supervisor to MH and contributed to study design, program content and edited the manuscript. All authors read and approved the final manuscript.

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Appendix D

Ethics Approval

APPROVAL after review
In reply please quote: HE15/354
Further Enquiries Phone: 4221 3386

30 October 2015

Ms Megan Hammersley
Early Start Research Institute
Faculty of Social Sciences
University of Wollongong NSW 2522

Dear Ms Hammersley

Thank you for your letter responding to the HREC review letter. I am pleased to advise that the Human Research Ethics application referred to below has been **approved.**

Ethics Number:	HE15/354
Project Title:	*Time2bHealthy*: The effect of an online lifestyle behaviour change program for parents of preschool-aged children
Researchers:	Ms Megan Hammersley, Professor Tony Okely, Dr Rachel Jones
Documents Approved:	Initial Ethics Application Email template for preschool directors V2 - 26/10/2015 Email template for Group University and TAFE general emails V2 - 26/10/2015 Flyer/Poster V2 - 26/10/2015 Participant Information Sheet for Parents V3 0 26/10/2015 Participant Consent Form for Parent and Child V3 - 27/10/2015 Time2bHealthy Telephone Script V1 - 26/10/2015 Child Feeding Questionnaire V1 - 26/10/2015 Parental Modeling Questionnaire V1 - 26/10/2015 Food Questionnaire V1 - 15/10/2015 Self-efficacy Questionnaire V3 - 15/10/2015 Sleep Questionnaire V2 - 27/08/2015 Screen Time Questionnaire V2 - 27/08/2015
Approval Date:	30 October 2015
Study Expiry Date:	29 October 2016

The University of Wollongong/Illawarra Shoalhaven Local Health District Social Sciences HREC is constituted and functions in accordance with the NHMRC National Statement on Ethical Conduct in Human Research. The HREC has reviewed the research proposal for compliance with the National Statement and approval of this project is conditional upon your continuing compliance with this document.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at http://www.uow.edu.au/research/rso/ethics/UOW009385.html. This report must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

As evidence of continuing compliance, the Human Research Ethics Committee also requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforseen events that might affect continued ethical acceptability of the project.

Please note that approvals are granted for a twelve month period. Further extension will be considered on receipt of a progress report prior to expiry date.

If you have any queries regarding the HREC review process, please contact the Ethics Unit on phone 4221 3386 or email rso-ethics@uow.edu.au.

Yours sincerely

Associate Professor Melanie Randle
Chair, Social Sciences
Human Research Ethics Committee

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

Appendix E

Participant Information Sheet

Project title: The effect of an online lifestyle behaviour change program for parents of preschool-aged children on weight and related risk factors.

Purpose of the research

Early childhood is a critical time for the development of healthy lifestyle practices and it is recognised that parents are important role models in the early years of life. This project will investigate the effect of an online healthy lifestyle program for parents of pre-school aged children on child weight, body composition, nutrition intake, physical activity, screen time and sleep. Families who have a preschool-aged (2-5 years) child who is on or above the 50^{th} body mass index (BMI) percentile are eligible to join the study.

Researchers

The research team includes Professor Tony Okely, Dr Rachel Jones and Mrs Megan Hammersley from the University of Wollongong .The contact details for the researchers are:

Professor Tony Okely
Early Start Research Institute
Faculty of Social Sciences
University of Wollongong
tokely@uow.edu.au
02 4221 4641

Dr Rachel Jones
Early Start Research Institute
Faculty of Social Sciences
University of Wollongong
rachelj@uow.edu.au

Mrs Megan Hammersley
PhD Candidate
Early Start Research Institute
Faculty of Social Sciences
University of Wollongong
mlh965@uowmail.edu.au

What we would like you to do

The research will be conducted with one parent and child per family, with most of the activities being carried out within your own home. If you choose to participate in this research, we will ask you to attend an initial appointment with your child at a venue TBA in your local community (or your home if you are not able to make it to the venue). At this appointment, your child will have the measures of their height and weight taken to calculate body mass index (BMI), which should take no longer than 5 minutes. We will also ask for your child to wear an Actigraph accelerometer (a device that measures physical activity and sleep, which is fitted around their waist with an elasticised band) over a 7-day continuous period. Parents will be asked to complete questionnaires asking about their child's dietary intake, child feeding practices, screen-time, sleep, role-modelling and self-efficacy (your confidence in being able to support your child in healthy lifestyle behaviours). These questionnaires should take around 30 minutes in total to complete. These measurements will be completed at the start of the study, approximately 11 weeks later and again around 6 months after the start of the study. In recognition of your time, you will be provided with a $20 Coles Myer gift card after you attend each of the follow-up appointments (at 11 weeks and 6 months after the commencement of the study).

This study is a randomised controlled trial. This means that half of the participants involved will be allocated to an intervention group and the other half to a control group. The research team will still take the same assessments described in the preceding paragraph, so that we can compare these with the intervention group. After the initial measurements have taken place, you will be randomly assigned to the 'Time2bHealthy' (intervention) or 'Raising Children' (control) group. The 'Time2bHealthy' group will receive access to an online program over an 11 week period. A series of modules on a number of topics, such as healthy eating, physical activity, screen time and sleep will be provided. Each module will take approximately 30 minutes to complete and can be done at a time that is convenient. The modules will require some reading and activities and you will be provided with email support. The program will also have a Facebook component and it is therefore required for you to have an active Facebook account in order to be eligible to participate. A secret Facebook group will be used, meaning that your membership of the group should not be visible to your Facebook friends. However, we cannot guarantee anonymity. We recommend that you set your privacy controls on Facebook so that you do not share more information than you intend to. Further information on Facebook groups is available at https://www.facebook.com/help/412300192139228/

The 'Raising Children' group will receive regular fortnightly emails featuring links to information on topics such as healthy eating, physical activity, screen time and sleep. Participants in this group will also be provided with access to the 'Time2bHealthy' program at the completion of the follow-up data collection period at 6 months. Access to this program will be provided without the additional email or Facebook group support.

Possible risks, inconveniences and discomforts

Apart from the inconvenience for your child wearing the accelerometer device, the time taken for measurements and completing the questionnaires, we foresee minimal risks for parents and children who partake in this study.

Your involvement in the study is **voluntary**. Declining to participate in the study will not affect your relationship with the University of Wollongong, nor will it affect your relationship with any organisation through which you may have been recruited. You may withdraw your participation from the study at any time and you can also withdraw any data up until the time that the study is submitted for publication. You are also able to withdraw yourself and any comments from the Facebook group.

Privacy and your information

To ensure confidentiality, all participants will be allocated a participant identification number which will be used for data analysis and writing up of results and therefore your name or your child's name will not be able to be identified in relation to your data. Please feel free to contact a member of the research team via phone, or email if you have any concerns about this at any point during the study. Any data will be stored securely by the research team in a locked filing cabinet or in password-protected files for electronic information. We will store the data from this study for a minimum of five years. The information collected from the study will be analysed and published in a thesis, journal articles and may be presented at conferences. Funding for this study has been provided by Australian Health Management.

Benefits of the research

Overweight and obesity in children is associated with a range of short- and long-term health consequences. Overweight children have at least twice the risk of remaining overweight into their adult life compared to children in the healthy weight range. Healthy lifestyle programs can reduce the likelihood of overweight and obesity continuing on into adulthood. This study will assess the effect of an online healthy lifestyle program for parents in reducing child weight and improving risk factors for overweight and obesity such as eating patterns, physical activity, screen time and sleep.

Ethics review and complaints

This study has been reviewed by the Human Research Ethics Committee (Social Science, Humanities and Behavioural Science) of the University of Wollongong. If you have any concerns or complaints regarding the way this research has been conducted, you can contact the UoW Ethics Officer on (02) 4221 4457 or email rso-ethics@uow.edu.au.

Thank you for your interest in this study.

Appendix F

Participant Consent Form

Project title: The effect of an online lifestyle behaviour change program for parents of preschool-aged children.

Researchers Names: Professor Tony Okely, Dr Rachel Jones and Mrs Megan Hammersley

I have been given information about the study "The effect of an online lifestyle behaviour change program for parents of preschool-aged children". I have read the participant information sheet and have had the opportunity to ask the researcher further questions I may have had. I understand that my participation and my child's participation in this research is voluntary and that we are able to withdraw from the study at any time without it adversely affecting our relationship with the University of Wollongong or any organisation I may have been recruited from.

I understand that the risks to myself and my child are minimal and I have read the information sheet and asked any questions that I may have about the risks. I understand that my child will be asked to wear an accelerometer around their waist for a 7-day period and that their height and weight will be measured on three occasions throughout the study. I understand that I will be asked to complete dietary intake, child feeding, sleep, screen-time, role-modelling and self-efficacy questionnaires on three occasions throughout the study.

I understand that after the initial measurements are taken, we will be assigned to the '*Time2bHealthy*' or '*Raising Children*' group.

I understand that the information from this study will be analysed and published in a thesis, journal articles and may be presented at conferences. I understand that my name and my child's name will not be identified in any analysis or publication of the results.

If I have any concerns or complaints regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 4457 or email rso-ethics@uow.edu.au

By signing below, I am consenting to participate in the research study.

I, ____ consent to participate in this research. (parent/guardian name)

Parent/guardian signature ____ Date ______________

By signing below, I am consenting for my child to participate in the research study

I give permission for my child ____to participate in this research. (child's name)

Parent/guardian signature 1____ Date______________

Parent/guardian signature 2____Date______________

Please note that two signatures are required unless there are reasons why consent cannot be obtained from the other parent/guardian.

Appendix G

Parent Questionnaires

Demographic Questionnaire

1. **What is your age?**________________________
2. **Are you?** Male Female
3. **What is your child's date of birth?**____/____/_________
4. **Is your child?** Male Female
5. **Are you of Aboriginal or Torres Strait Islander Origin?** □ No □ Aboriginal

   □ Torres Strait Islander □ Other_____________________
6. **What is the main language you speak at home?**

   □ English □ Other (Please specify)_________________________
7. **Postcode_________________**
8. **Referrer**

   □ Preschool
   □ Playgroup
   □ General Practice
   □ Early Childhood Nurse / Centre
   □ Responded to email
   □ Responded to flyer
   □ Responded to media advertisement

9. **How many hours per week does your child attend formal child care? (eg preschool, child care centre, family day care)______________________**hours per week
10. **How many hours per week does your child attend informal child care?** (eg grandparents, friends)______________________hours per week
11. **How many children (under the age of 18) are in your household?__________________**
12. **How many adults (18 years and over) are in your household?** ___________________
13. **What is your marital status?** □ Single/separated/divorced □ Married/with partner
14. **What is your highest level of education?**
    - □ No schooling / did not complete primary school
    - □ primary school or equivalent
    - □ year 10 or equivalent (eg school certificate)
    - □ year 12 or equivalent (eg higher school certificate)
    - □ trade/apprenticeship/certificate (eg hairdresser/plumber)
    - □ university degree
    - □ post-graduate qualification (eg Masters, PhD)
15. **What is your (and your partners) disposable income per week (ie after taxes)?**

	You	Your partner
Less than $580/week	□	□
Between $580 and $1240/week	□	□
More than $1240/week	□	□

16. **What is your relationship to this child?**

□ biological mother

□ biological father

□ step mother

□ step father

□ adoptive mother

□ adoptive father

□ grandmother

□ grandfather

□ aunt

□ uncle

□ male cousin

□ female cousin

□other (please specify the relationship to the child)___________________________

17. **What is your weight?**__________(kg) and **height**? ___________(cm)

18. **What is your partner's weight**? ___________(kg) and **height**?___________(cm)

19. **What was the child's birth weight and length?** Weight __.__kg Height __.__cm (write don't know if you don't know)

20. **At what week of gestation was this child born?** ____weeks of gestation (write don't know if you don't know)

21. **If this child was breastfed, how long for?**

Days ________

Weeks ________

Months ________

Screen Time Questionnaire

1. **Do you have rules about screen entertainment?** (screen entertainment includes TV, DVDs, iPad, tablet, computer, consoles and hand held games)

   Yes / No

2. **Does your child have a TV in their bedroom?** Yes / No

3. **How often does your child watch TV while eating a meal?**

   Never/rarely   1-3 x week   4-6 x week   1/day   2 or more x day

4. **In total, how many electronic devices are available in your household, including in cars, for your child to use** (please exclude devices that you don't allow your child to use)

5. **How long does your child usually spend watching TV programs / movies / internet clips <u>on traditional devices</u>** (TV, DVD)
on a typical weekday (Monday to Friday) ___________hours__________minutes/day
on a typical weekend day (Saturday and Sunday) ____________hours__________minutes /day

6. **How long does your child usually spend watching TV programs / movies / internet clips <u>on other devices</u>** (eg tablet, iPad, DVD in cars, computer, laptop, handheld mobile phone etc), on a typical weekday (Monday to Friday)
___________hours__________minutes/day
on a typical weekend day (Saturday and Sunday) ____________hours__________minutes /day

7. **How long does your child usually spend playing games/apps on <u>portable/handheld devices</u>** (tablet, iPad, mobile phone, handheld game system (eg Nintendo DS), iPod
on a typical weekday (Monday to Friday) ___________hours__________minutes/day
on a typical weekend day (Saturday and Sunday) ____________hours__________minutes/day

8. **How long does your child usually spend playing <u>console games (non-active)</u> on console system** (eg playstation, Xbox)
on a typical weekday (Monday to Friday) ___________hours_________minutes/day
on a typical weekend day (Saturday and Sunday) ____________hours_________minutes /day

9. **How long does your child usually spend playing <u>console games (active)</u> on console system** (eg Wii, Xbox Kinect)
on a typical weekday (Monday to Friday) ___________hours_________minutes/day
on a typical weekend day (Saturday and Sunday) ____________hours_________minutes/day

Sleep Questionnaire

1. **Does your child have a regular bedtime? (Yes/No). If yes, what time is it? ___________**

2. **How many hours per night does your child usually sleep at the moment?____________**

3. **What time does your child usually wake up in the morning?______________**

4. **How many hours does your child usually sleep/nap during the day at the moment? (if no nap, please answer ‘0’)_________________**

5. **How long after going to bed does your child usually fall asleep?**

<15 minutes   15-30 min   30-45 min   45-60 min   >60 min

6. **My child goes to bed reluctantly**

Never   once or twice a month   1 or 2 times/week   3 to 5 times/week   every night

7. **My child has difficulty getting to sleep at night (and may require a parent to be present)**

Never   once or twice a month   1 or 2 times/week   3 to 5 times/week   every night

8. **My child does not fall asleep in his or her own bed**

Never   once or twice a month   1 or 2 times/week   3 to 5 times/week   every night

Child Feeding Questionnaire

1. I have to be sure that my child does not eat too many sweets (lollies, ice-cream, cake or pasties)

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

2. I have to be sure that my child does not eat too many high fat foods

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

3. I have to be sure that my child does not eat too many of their favourite foods

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

4. I intentionally keep some foods out of my child's reach

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

5. I offer sweets (lollies, ice-cream, cake, pastries) to my child as a reward for good behaviour

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

6. I offer my child their favourite foods in exchange for good behaviour

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

7. If I did not guide or regulate my child's eating, they would eat too many junk foods

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

8. If I did not guide or regulate my child's eating, they would eat too much of their favourite foods

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

9. My child should always eat all the food on their plate

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

10. I have to be especially careful to make sure my child eats enough

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

11. If my child says “I’m not hungry”, I try to get them to eat anyway

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

12. If I did not guide or regulate my child’s eating, they would eat much less than they should

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

Food Questionnaire

1. How many serves of the following beverages does your child drink on a USUAL day? (one serving equals ½ cup or 125ml)

Fruit juice	Cordial or soft drink	Water	Plain Milk	Flavoured Milk
□None	□None	□None	□None	□None
□1	□1	□1	□1	□1
□2	□2	□2	□2	□2
□3	□3	□3	□3	□3
□4	□4	□4	□4	□4
□5	□5	□5	□5	□5
□6 or more	□6 or more	□6 or more	□6 or more	□6 or more
□Don't know	□Don't know	□Don't know	□Don't know	□Don't know

2. What type of milk does your child usually drink?
   □ Whole milk (full cream)
   □ Low or reduced fat milk
   □ Skim (non-fat) milk
   □ Soy milk
   □ Not sure
   □ Other (please specify)________________________
   □ Doesn't drink milk

3. How many servings of the following foods does your child have on a USUAL day?

Vegetables (cooked & raw and baked beans) (1/2 cup cooked vegetables or baked beans or 1 cup salad)	Fruit (fresh, dried & tinned) 1 apple or banana or 1 cup grapes or 1/2 tbsp. sultanas)
□None	□None
□1	□1
□2	□2
□3	□3
□4	□4
□5 or more	□5 or more
□Don’t know	□Don’t know

4. How often would your child USUALLY eat and drink the following foods and beverages?

	Never or rarely	1-3 times / month	1-2 times / week	3-4 times / week	5-6 times / week	Once a day	2 or more times / day	Don't know
Takeaway or fast food (eg hot chips, hamburgers, chicken nuggets, sausage rolls, hot dog, pizza)								
Sugary cereals (eg Coco Pops, Froot Loops etc)								
Potato chips or other salty snacks (eg twisties or Doritos)								
Sweets (eg lollies or chocolate)								
Cakes, doughnuts, sweet biscuits or muffins								
Sugary drinks (eg soft drink, cordial, fruit drinks, sports/energy drinks								

Parent Self-efficacy Questionnaire

Nutrition

How confident are you that you can…?

1. promote healthy eating habits for your child?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

2. arrange eating regular meals at the dinner table (away from the TV and other electronic devices)?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

3. restrict consumption of soft drinks and other sugar-sweetened drinks by your child to special occasions (such as birthday parties)?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

4. make it possible for your child to eat meals according to the Australian Dietary Guidelines?

0	1	2	3	4	5	6	7	8	9	10	11
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree	not aware of dietary guidelines

5. have your child eat fruit and vegetables every day?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

6. prepare healthy and nutritious snacks for your child?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

Physical Activity

How confident are you that you can…?

7. get your child engaged in active play indoors and outdoors?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

8. arrange opportunities for you and your child to be physically active together, for example, play outdoors?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

9. take part unplanned active play/activities with your child?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

10. provide activities that are suitable for your child's age

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

Screen Time

How confident are you that you can…?

11. limit your child's inactivity in front of the computer, TV and other screens (such as console games, tablets, smartphones/ipods (for games) and other hand held game devices?)

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

12. get your child engaged in alternative activities to screens (such as imaginative play, quiet activities (eg. colouring in) or outdoor game/activities)?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

Sleep

How confident are you that you can…?

13. establish/maintain a regular bedtime for your child?

0	1	2	3	4	5	6	7	8	9	10
Not at all		to a very low degree		to some degree		to quite a degree		to a high degree		to a very high degree

Parental Modelling Questionnaire

1. I try to influence my child's food preferences by eating a wide variety of healthy foods myself

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

2. I try to influence my child's physical activity by participating in physical activity myself

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

3. I try to influence my child's screen-time by limiting my own screen-time

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

4. I try to influence my child's sleep habits by talking to them about my own good sleep habits

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree

Appendix H

Time2bHealthy Intervention Condition Details

Table H.1: Modifications made to the Time2bHealthy Online Program for the RCT following the Pilot Study

Module	Changes
Overall / All Modules	• Quizzes were added to all modules to review the content covered in the previous module • Goal setting component was enhanced to ask participants about their readiness and motivation for change. Participants were also asked about barriers and strategies to overcome them and then guided to develop an action plan to support their goal, including a plan to monitor their progress.
Module 2 – Healthy Meals	• Updated to align with the 2013 Australian Dietary Guidelines (National Health and Medical Research Council of Australia, 2013), involving changes in recommended number of serving of core food groups. • Information on the World Health Organization free sugar guidelines was added (World Health Organization, 2015) • Information on Australian Health Star Rating was added (Commonwealth of Australia, 2014) • Content on parental food restriction and pressure to eat was added • Videos on 'role modelling', 'shopping for healthy foods', 'involving children in food preparation' and 'making healthy foods fun' added throughout the module.
Module 3 – Healthy Snacks and Drinks	• Videos added on 'sometimes foods' and 'sharing healthy foods together' • Snack preparation suggestions were expanded to include more core foods • Snack lists were updated according to the current availability of commercial foods. • Tips on portion sizes and availability of snacks in the home were added • Recommendations on frequency of juice and soft drink consumption was clarified
Module 4 – Physical Activity	• Amended slightly to align with the newly released Australian Physical Activity and Sedentary Behaviour Guidelines (Australian Government Department of Health 2014) • Videos demonstrating some of the creative outside activities were added • Information on wet weather alternatives, safety, supporting children to be active and fitting physical activity into your life were added
Module 5 – Screen-time	• Updated to align with the newly released Australian Physical Activity and Sedentary Behaviour Guidelines (Australian

	Government Department of Health 2014) and included recommendations to break up periods of sitting. • Content which referred to types of screens was updated to include the most current popular recreational screen options • Recent statistics on child use of screens was added
Module 6 – Sleep (new module)	• Included background information on child sleep, the importance of sleep, assessment of child sleep patterns, current sleep guidelines, how to improve sleep, sleep routines, video on establishing good sleep habits and a sleep planner

Table H.2: Detailed components of the *Time2bHealthy* online program

Module	Module Content	Activities	Videos	Time Commitment	Guidelines Informing Content	Related Outcomes
Module 1 – Introduction	- Why was Time2bHealthy created? - Description of modules - Goal-setting overview - Description of support from Health Consultants and Facebook group - Timetable for program	- Log onto Facebook group and introduce yourself to the group - Weekly planner	N/A	15 minutes over 1 week	N/A	N/A
Module 2 – Healthy Meals	- What is healthy eating? (overview of Australian Guide to Heathy Eating and benefits of healthy eating) - How much food (dietary guideline number of servings and serving sizes of core food groups) - Serving sizes (examples of appropriate serving sizes for children)	- Measuring serving sizes - Estimating sugar content of breakfast cereals - Choosing strategies to reduce sugar consumption - Choosing strategies to reduce saturated fat consumption	Raising Children Network videos: - Shopping for healthy food together - Making healthy foods fun - Planting herbs at home	30 minutes over 2 weeks	Australian Dietary Guidelines (National Health and Medical Research Council of Australia, 2013a)	- BMI - kJ/KG body weight - Percentage of sugar from kJ - Percentage of saturated fat from kJ - Serves of vegetables - Discretionary food score

Module	Module Content	Activities	Videos	Time Commitment	Guidelines Informing Content	Related Outcomes
	- How to reduce sugar consumption (discretionary foods, breakfast cereals) - Choosing breakfast cereals - How to read food labels (instructions on how to read food labels, what to look for and how to compare products, information on the Health Star Rating) - How to reduce fat consumption - How to increase vegetable consumption - Recipe modification (examples of modified recipes) - Getting the balance right (role modelling, eating together, portion sizes, restriction/pressure to eat, self-regulation) - Tips	- Modifying a recipe and sharing with Facebook group - Goal-setting	- Setting a good example by eating well - Preparing dinner – involving your child			- Parent self-efficacy (nutrition) - Parental modelling - Child feeding (restriction) - Child feeding (pressure to eat)

Module	Module Content	Activities	Videos	Time Commitment	Guidelines Informing Content	Related Outcomes
	- Now is the time for change (goal setting) - Summary / Recipe ideas					
Module 3 – Healthy Snacks and Drinks	- Why healthy snacks and drinks? (overview of benefits) - Which snacks and drinks? (how to identify foods high in sugar, examples of healthy snacks) - Which snacks are consumed in your house? (guidelines to choose healthy snacks, what to look for on a food label) - What drinks are consumed in your house? - Which drinks? - Best drinks - Tips - How did you go last week (goal review) - Now is the time for change (goal-setting) - Summary	- Quick recap of the meals module (quiz) - Label reading - Share favourite healthy snack on Facebook group - Activity to select regular snacks consumed from a list which are then categorised into everyday, sometimes and rarely foods - Amount of sugar and fat in drinks - Goal review - Goal-setting	Raising Children Network videos: - Sometimes foods - Sharing healthy snacks together	30 minutes over 2 weeks	Australian Dietary Guidelines (National Health and Medical Research Council of Australia, 2013a)	- BMI - kJ/KG body weight - Percentage of sugar from kJ - Percentage of saturated fat from kJ - Serves of fruit - Serves of vegetables - Discretionary food score - Parent self-efficacy (nutrition) - Parental modelling

Module	Module Content	Activities	Videos	Time Commitment	Guidelines Informing Content	Related Outcomes
Module 4 – Physical Activity	- What is physical activity? - Why do physical activity (guidelines overview) - What physical activity is happening right now? - How to increase physical activity - Space - Equipment - Creative outside activities - How parents can help - When to increase physical activity - Tips - How did you go last week (goal review) - Now is the time for change (goal-setting) - Summary	- Quick recap of the snacks and drinks module (quiz) - Physical activity planner - Exploring equipment - Share with others on Facebook equipment that you have or equipment sales you have noticed	Creative outside activity videos: - Steal the braid - Jumping numbers and shapes - Follow the leader - Bouncing on the spot - Sliding with partner - Partner kicking, skittles)	30 minutes over 2 weeks	Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (0-5 years) (Australian Government Department of Health, 2014)	- Percentage sedentary - Percentage LMVPA Percentage MVPA - Parent self-efficacy (physical activity) - Parental modelling
Module 5 – Screen-time	- What is sedentary screen time and how much? (guidelines)	- Quick recap of physical activity module (quiz)	- Video outlining equipment	30 minutes over 2 weeks	Australia's Physical Activity and Sedentary	- Percentage sedentary

Module	Module Content	Activities	Videos	Time Commitment	Guidelines Informing Content	Related Outcomes
	- Why limit sedentary screen-time? - How much sedentary screen-time is happening now? - If not sedentary screen-time then what? - Let their imagination run wild	- Screen-time planner - Share on Facebook group the equipment that you use to encourage imaginative play	that can be used for imaginative play		Behaviour Guidelines for Children (0-5 years) (Australian Government Department of Health, 2014)	- Screen-time (weekday) - Screen-time (weekend) - Parent self-efficacy (screen-time) - Parental modelling
Module 6 – Sleep	- Sleep overview - What are my child's sleep patterns now? - How long should children sleep for? - What can I do? - Remember: persistence with resistance	- Quick recap of screen-time module (quiz)	- Parent video on establishing good sleep habits	30 minutes over 2 weeks	National Sleep Foundation Sleep Time Duration Recommendations (Hirshkowitz et al., 2015)	- Sleep duration - Sleep latency - Sleep reluctance - Parent self-efficacy (sleep) - Parental modelling

References

Australian Government Department of Health. (2014). *National Physical Activity and Sedentary Behavioiur Guidelines for Children (0-5 years).* Canberra, Australia: Commonwealth of Australia.

Commonwealth of Australia. (2014). Health Star Rating.Retrieved from: http://healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/content/home.

World Health Organization (2015). *Guideline: Sugars Intake for Adults and Children*. Geneva: World Health Organization.

Time2bHealthy Program Screenshots

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 2

Meals

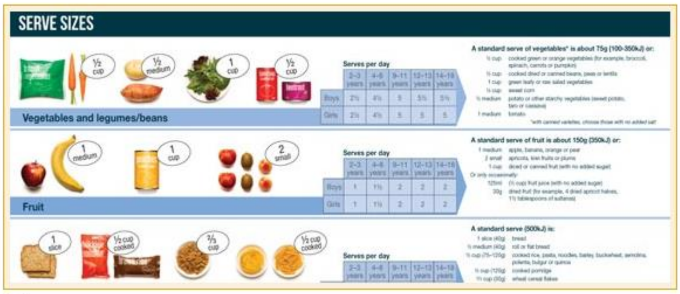
< Return to Main Menu | My notes

1 2 3 4 5 6 7 8 9 10 11 12

Print page

2 How much food?

Children of different ages require different amounts of food. The document below shows the current Australian recommendations for children and serving sizes. Take a moment to look how different the recommendations are for younger children compared to older children.



Download the "Serving Sizes for Children Brochure" (970kB PDF)

Were you surprised by the number of serves and the serving sizes?

Serving sizes for adults can be found in the following document:

Good nutrition is the bedrock of lifelong health, and it begins in infancy.

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 3

Snacks and Drinks

< Return to Main Menu | My notes

1 2 3 4 5 6 7 8 9 10 11 12 13 14 Print page

6 Choose snacks

Activity

Here is a list of many of the common snacks that children enjoy.

1. Read through the list and select the ones that you regularly give to your child.
2. Once you have finished doing this for the Bars, click on the Biscuits and choose your snacks.
3. Do the same for Chips, Fruit and Other
4. When you have finished all the sections press the Finished button and then the Next button.

The information that you have entered on this page will be used in the next activity.

Common snacks

Bars | Biscuits | Chips | Fruit | Other

- [ ] Fruit strap / leather (100% fruit)
- [x] Fruit strings / roll-ups
- [x] K-time twists
- [ ] Kez's choc mud bar / sticky date bar *
- [ ] LCMs
- [x] Le Snack
- [ ] Milo bar
- [x] Muesli Bars (yoghurt)
- [ ] Muesli Bars Choc-chip
- [ ] Munchables
- [ ] Nice and natural supergrain
- [ ] Nutrigrain bar
- [ ] Weight watchers cereal bars

Finished

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 3

Snacks and Drinks

7 Which snacks?

We have grouped the snack foods into three categories:

- Often: can be eaten every day
- Sometimes: should be eaten once or, at most, twice a week
- Rarely: special occasions foods (i.e. birthday parties, holidays, special outings, etc)

1. Look through the list below and see what categories your snacks are in.
2. Click on the headings Often, Sometimes and Rarely to look at the categories for your snacks.
3. Are most of the snacks that you offer in the Sometimes or Rarely categories?
4. Are there snacks from the Often category that you could buy this week? Jot these down in the notebook.

Make sure you take note of the serving size. (e.g. one bar, one small packet, one biscuit, etc). These serving sizes are recommended for young children.

Snack recommendations

Often | Sometimes | Rarely

Snacks you selected	Recommended serving
Diced peaches	1 tub
Fresh fruit *	1 medium serve
Corn thins	1-2 thins
Crumpets	1 crumpet

Other snacks in this category	Recommended serving
Rice Crackers (wholegrain)	4-6 crackers
Waterthins crackers	4-6 crackers
Pop corn (air popped at home) *	1 cup
Packaged popcorn *	1 small packet
Apple/Strawberry Puree	1 tub/pouch

Recommendation

These food items can be eaten daily as a healthy and nutritious snack.

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 4

Physical Activity

< Return to Main Menu | My notes

1 2 3 **4** 5 6 7 8 9 10 11 12 13 14 Print page

4 What physical activity is happening now?

The next activity will help you look at the amount of activity your child does in a typical week.

Activity

1. Below is the weekly planner that you completed in Module 1
2. Have a quick look over it and make sure that it is still a typical week. If things have changed slightly then use the palette to update the planner.
3. Once you have updated the planner, use the *"Doing now" highlighter (green)* to highlight the times when your child is **regularly** active - remember to highlight both the structured and unstructured activities your child might regularly participate in.
4. Press the **Save** button once you have finished.

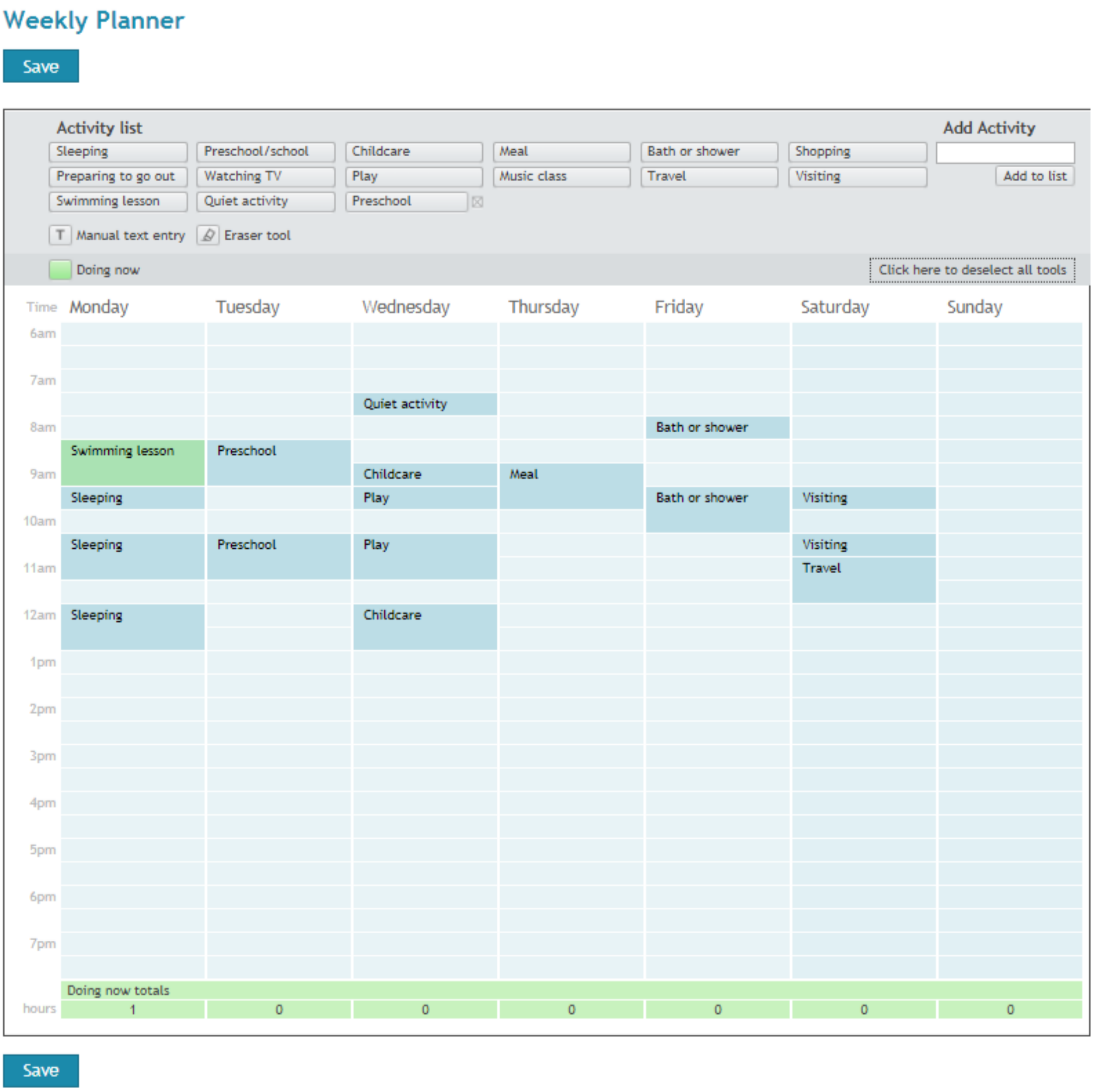
Remember that structured activities include things like gym fun, learn-to-swim and unstructured activities include bike riding, trampolining.

Using the highlighting tools

Show "Highlighting time slots" animation

Click one of the highlighter tools in the palette and then click on the time slot you want to highlight.

To remove the highlight, click the time slot again and it will be removed.


Weekly Planner
Save
Activity list
Sleeping
Preschool/school
Childcare
Meal
Bath or shower
Shopping
Preparing to go out
Watching TV
Play
Music class
Travel
Visiting
Swimming lesson
Quiet activity
Preschool
Add Activity
Add to list
Manual text entry
Eraser tool
Doing now
Click here to deselect all tools
Time
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
6am
7am
8am
9am
10am
11am
12am
1pm
2pm
3pm
4pm
5pm
6pm
7pm
Quiet activity
Bath or shower
Swimming lesson
Preschool
Childcare
Meal
Sleeping
Play
Bath or shower
Visiting
Sleeping
Preschool
Play
Visiting
Travel
Sleeping
Childcare
Doing now totals
hours
1
0
0
0
0
0
0
Save

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 5

Screen Time

10 Tips

Tips and tricks for parents

Click on each heading below to view the tips and tricks.

1. Be excited

- Alternative activities will only be exciting if you are excited about them.
- Be involved and get excited about doing other activities that are not sedentary screen time based.
- Young children love it when you enter into their imaginary world. If you are excited about other activities that don't involve screens then they will be excited as well.
- Create a new norm for your family so that what was normal before is no longer the norm. Establishing this pattern will be challenging to begin with but your children will soon become used to the new routine.

2. Take the TV TURN OFF challenge!

- Can you and your child go 1 afternoon, 1 day, 3 days or a week without watching TV?
- Who can watch the least amount of TV? Each family member has a TV budget (7 hours per week for children under 5, and 14 hours per week for adults and children over 5). On a chart mark off the hours when they have been used. Who will be the winner?
- Practice turning the TV off at every mealtime, savouring your meal and spending time asking about each other's day.

3. How much time do YOU spend in sedentary screen time?

- Take a moment to think about the time that you spend in sedentary screen time?

Time2bHealthy Program

Making healthy living a part of your family's routine

Module 6

Sleep

< Return to Main Menu | My notes

1 2 3 4 5 6 7 8 9 10 11 **12** Print page

12 A recap of the Sleep module

Please answer the following questions:

1. How many hours of sleep does a child aged 3-5 years need each night?

- a. 7-8 hours
- b. 8-10 hours
- c. 10-13 hours (correct answer)
- d. 14-16 hours

2. By the age of 3-4, what percentage of children no longer nap during the day?

- a. 25%
- b. 50%
- c. 75% (correct answer)
- d. 90%

3. What are some of the signs of tiredness? (select all that apply)

- a. appearing too tired to carry out normal activities during the day (correct answer)
- b. crankiness (correct answer)
- c. clinginess (correct answer)
- d. hyperactivity (correct answer)

Appendix I

Comparison Condition Details

Table I.1: Comparison group *Raising Children Network* content

Week	Topic and link to webpage
1	**Dietary guidelines in pictures** *2-3 years* http://raisingchildren.net.au/articles/dietary_guidelines_children_2-3_years_pip.html *4-8 years* http://raisingchildren.net.au/articles/dietary_guidelines_children_4-8_years_pip.html/context/212
Week 2	**Making family meals enjoyable** http://raisingchildren.net.au/articles/mealtimes.html/context/212
3	**Healthy drinks for kids and teenagers** http://raisingchildren.net.au/articles/healthy_drinks_for_kids.html
4	**Food labels: nutritional information and ingredients** https://raisingchildren.net.au/teens/healthy-lifestyle/nutrients/food-labels
5	**Physical activity for children: how much and why?** http://raisingchildren.net.au/articles/physical_activity_how_much_for_children.html
6	**Physical activity for children** https://raisingchildren.net.au/babies/play-learning/active-play/physical-activity-for-young-children
7	**Screen-time** http://raisingchildren.net.au/articles/screen_time.html
8	Preschooler sleep: what to expect http://raisingchildren.net.au/articles/preschoolers_sleep_nutshell.html
9	**How to sleep better: 10 tips for children** http://raisingchildren.net.au/articles/good_sleep_habits_tips.html
10	**Young children's health: what to expect** https://raisingchildren.net.au/toddlers/health-daily-care/health-concerns/young-children-s-health
11	**Childhood obesity** https://raisingchildren.net.au/toddlers/nutrition-fitness/common-concerns/child-obesity

Raising Children Network Website Screenshots

raisingchildren.net.au
the australian parenting website

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Home / Preschoolers / Nutrition & fitness / **Healthy eating habits**

SUITABLE FOR 2-18 YEARS

Making family meals enjoyable: six tips

PRESCHOOLERS
3-5 years

- Behaviour
- Connecting & communicating
- Development
- Health & daily care
- Nutrition & fitness
  - Nutrients
  - Daily food guides
  - Healthy eating habits
  - Family meals
    - Meal plan & shopping list
    - Family meals: tips
  - Breakfast & lunches
  - Cooking with kids
  - Shopping for healthy food
  - Food & recipes
  - Common concerns
  - Physical activity
- Play & learning
- Safety
- Sleep
- Family life

By Raising Children Network

Share 1 | Tweet | Save | Share

Family life is so busy – work, child care, preschool and school, after-school activities, homework and more. Regular family meals give everybody a chance to catch up and enjoy each other's company. Here's how to get the most out of your family meals.

Benefits of family meals

Family life often comes with a busy schedule. It isn't always easy to put a meal on the table, let alone get the whole family to sit down together to enjoy it. But a regular family mealtime is worth the effort.

Whether it's nightly dinners or a special Sunday lunch, family meals are perfect times to catch up, connect and communicate with each other. This can be especially important for busy older children and teenagers.

Your child can also learn a lot about food and eating by watching what you do at mealtimes. For example, eating with the rest of the family helps younger children learn to eat the same healthy food as everyone else. It can encourage picky eaters to try new foods.

And you can use family meals to model good eating habits, as well as the behaviour you want to see when your family comes together. This is about learning to use spoons, forks and chopsticks for younger children. It's also about things like taking turns to talk and listening while others share their news.

did you know

Children and teenagers who regularly eat meals with their families do better in lots of ways, from mental and physical health to school results.

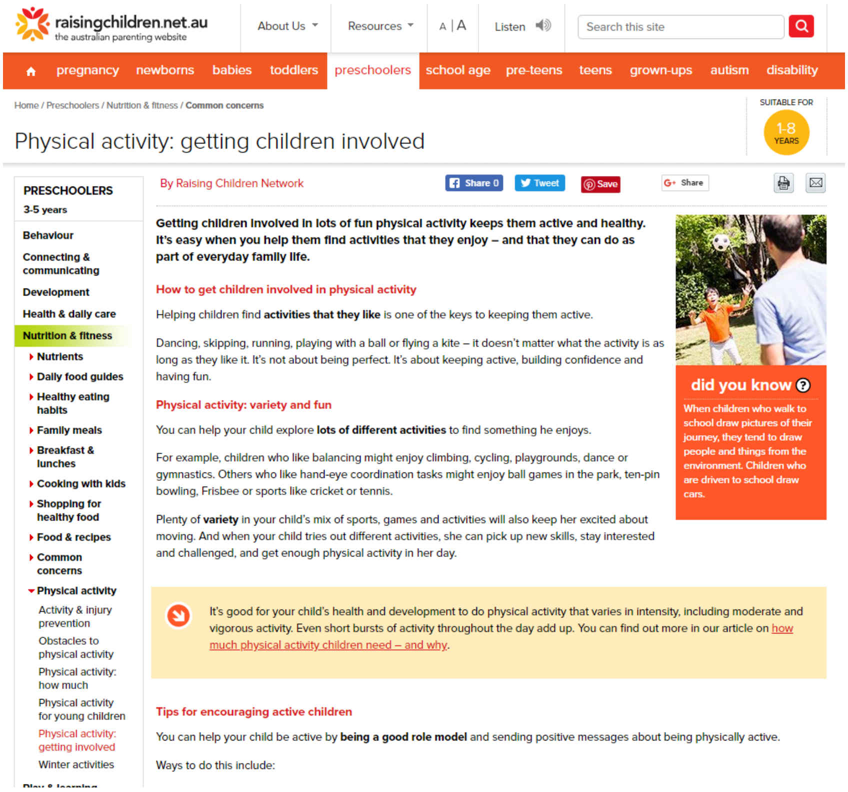
Six ways to make family meals enjoyable

1. Set aside regular times to eat together
When you put these times in your weekly schedule, you're all more likely to be there. Having your meal at a table, with the television and phones turned off, can make this time even more special.

2. Reduce the rush
If you allow around half an hour for family meals, it gives your children plenty of time to eat. They'll have the chance to try new foods and develop good eating habits. This also gives you time to relax, chat and enjoy your family.

If your toddler finds it hard to sit still for half an hour, you could let him move around a bit. But it's best to let him eat only when he's sitting at the table.

3. Get everyone involved
Involving your family in choosing and preparing the meal increases the chance that they'll eat it. It can also help fussy eaters to try new food.



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Home / Preschoolers / Nutrition & fitness / **Common concerns**

SUITABLE FOR 1-8 YEARS

Physical activity: getting children involved

PRESCHOOLERS
3-5 years

- Behaviour
- Connecting & communicating
- Development
- Health & daily care
- Nutrition & fitness
  - Nutrients
  - Daily food guides
  - Healthy eating habits
  - Family meals
  - Breakfast & lunches
  - Cooking with kids
  - Shopping for healthy food
  - Food & recipes
  - Common concerns
  - Physical activity
    - Activity & injury prevention
    - Obstacles to physical activity
    - Physical activity: how much
    - Physical activity for young children
    - Physical activity: getting involved
    - Winter activities

By Raising Children Network

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Getting children involved in lots of fun physical activity keeps them active and healthy. It's easy when you help them find activities that they enjoy – and that they can do as part of everyday family life.

How to get children involved in physical activity

Helping children find **activities that they like** is one of the keys to keeping them active.

Dancing, skipping, running, playing with a ball or flying a kite – it doesn't matter what the activity is as long as they like it. It's not about being perfect. It's about keeping active, building confidence and having fun.

Physical activity: variety and fun

You can help your child explore **lots of different activities** to find something he enjoys.

For example, children who like balancing might enjoy climbing, cycling, playgrounds, dance or gymnastics. Others who like hand-eye coordination tasks might enjoy ball games in the park, ten-pin bowling, Frisbee or sports like cricket or tennis.

Plenty of **variety** in your child's mix of sports, games and activities will also keep her excited about moving. And when your child tries out different activities, she can pick up new skills, stay interested and challenged, and get enough physical activity in her day.

did you know

When children who walk to school draw pictures of their journey, they tend to draw people and things from the environment. Children who are driven to school draw cars.

It's good for your child's health and development to do physical activity that varies in intensity, including moderate and vigorous activity. Even short bursts of activity throughout the day add up. You can find out more in our article on how much physical activity children need – and why.

Tips for encouraging active children

You can help your child be active by **being a good role model** and sending positive messages about being physically active.

Ways to do this include:

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the australian parenting website

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Home / School Age / Play, media & technology / **Screen time & healthy screen use**

SUITABLE FOR 0-18 YEARS

Screen time

SCHOOL AGE
5-8 years

- Behaviour
- Connecting & communicating
- Development
- Health & daily care
- Nutrition & fitness
- School & learning
- Play, media & technology
  - Play & school-age development
  - Getting play started
  - Low-cost play ideas
  - Outdoor play
  - Active play
  - Playing with others
  - Media
  - Screen time & healthy screen use
    - Healthy screen time: 6-11 years
    - Healthy gaming: children & teens
    - Screen time
  - Digital safety
- Safety

By Raising Children Network

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Screen time is the time you spend each day using devices with screens, like TVs, video consoles, smartphones and tablets. There are benefits and risks to using these devices, so a healthy family lifestyle includes limits on daily screen time.

What is screen time?

Screen time is the time you spend watching TV or DVDs, using computers, playing video or hand-held computer games, or using tablets or smartphones.

Screen time can be:

- interactive – for example, playing video games, communicating via Skype, or using online tools to draw pictures
- not interactive – for example, sitting still and watching movies, TV programs or YouTube videos
- educational – for example, doing maths homework online
- recreational – for example, playing games or watching videos for fun.

Screen time guidelines

Child development experts recommend **limiting children's daily screen time**. This is because real-life interactions with you and others are much better for your child's wellbeing, learning and development.

The **latest guidelines** from the American Academy of Pediatrics (AAP) suggest that:

- children under 18 months should avoid screen time, other than video-chatting
- children aged 18 months to 2 years can watch or use high-quality programs or apps if adults watch or play with them to help them understand what they're seeing
- children aged 2-5 years should have no more than one hour a day of screen time with adults watching or playing with them
- children aged 6 years and older should have consistent limits on the time they spend on electronic media and the types of media they use.

What do screen time limits mean for your child?
Screen time limits are about making sure your child enjoys lots of healthy, fun activities – both with and without screens.

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Home / Preschoolers / Sleep / **Understanding sleep**

SUITABLE FOR 3-5 YEARS

Preschooler sleep: what to expect

PRESCHOOLERS
3-5 years

- Behaviour
- Connecting & communicating
- Development
- Health & daily care
- Nutrition & fitness
- Play & learning
- Safety
- Sleep
  - Understanding sleep
    - Sleep: 20 FAQs
    - Sleep & learning
    - About sleep
    - Preschooler sleep
  - Better sleep & settling
  - Sleep problems
  - Night-time problems
  - Nightmares, night terrors & sleepwalking
- Family life

By Raising Children Network

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Most preschoolers need 11-13 hours of sleep a night, and some still nap during the day. Preschoolers sometimes have sleep problems like nightmares and night terrors or getting out of bed. A consistent bedtime routine is the best way to handle many of these issues.

Preschooler sleep: what you need to know

Children aged 3-5 years need **around 11-13 hours of sleep a night**. Some might also have a day nap of about an hour.

Sleep is important for your preschooler's health, growth and development. When children sleep well, they're more settled and happy during the day. Getting the right amount of sleep also strengthens your child's immune system and reduces the risk of infection and illness.

Night terrors and nightmares

Night terrors and nightmares are quite common among preschoolers. Night terrors and nightmares happen at different times of the night, and they need to be managed differently.

Night terrors
Night terrors happen in the first few hours of the night, when children are in deep sleep. If your child is having a night terror, he's actually asleep although he looks like he's awake. For example, his eyes might be open or he might be moving around. But he won't respond to you as he normally would.

Night terrors can be frightening to watch, but **they don't hurt your child**.

Don't wake your child during a night terror, because this often makes it last longer. Instead, wait for your child to stop crying and thrashing about. Guide her back to bed if she has climbed out. Children usually settle back to sleep quickly after a night terror and have no memory of it in the morning.

Nightmares
Nightmares tend to happen in the second half of the night, when children dream the most. They're related to preschoolers' developing imaginations. If your child has a nightmare, he might wake up upset. He'll be able to remember the nightmare and talk to you.

If your child has a nightmare, she'll need cuddles, comfort and reassurance – for example, 'Bad dreams are very scary, aren't they?'

Appendix J

Media Coverage of *Time2bHealthy* RCT

Elise Pitt

SHARE

11/02/2016

Media Resources

Putting a lid on child obesity with Australian-first online program

Online lifestyle program promoting healthy weight in preschoolers to be trialled in the Illawarra.

An Australian-first online healthy lifestyle program that aims to promote healthy weight in preschoolers will be trialled in the Illawarra over the next 12 months.

Researchers from UOW are seeking 160 parents from the Illawarra area to take part in the trial of the 'Time2bHealthy' Program, which they anticipate will improve children's eating habits, physical activity, screen time and sleep as well as help them reach and maintain a healthy weight.

The 11-week online program for parents with preschool aged children who are overweight, or at risk of becoming overweight, is the first of its kind in Australia. Participants will be asked to answer a series of questionnaires, have measurements taken and report on changes in eating habits and physical activity over a 12-month period.

Megan Hammersley, a PhD student at UOW's Early Start Research Institute (ESRI) who has been an Accredited Practising Dietitian for more than 15 years, will run the study, which focuses on providing guidance on how to implement change, rather than simply supplying information.

"It can help families to establish life-long healthy habits in the areas of healthy eating, physical activity, screen-time and sleep," Megan said.

"Quite often it is difficult for parents to attend traditional face-to-face appointments or sessions due to travel, cost and childcare for other siblings. Because this program is online, it can be completed in the participant's own home and can be worked on at a time that's convenient to them."

Megan said the program, which was developed a few years ago and trialled with a small group of parents, shows great promise, with parents who completed the program commenting that it was "helpful and practical".

"Parents increased their knowledge about dietary intake and physical activity recommendations for children. There was also a reduction in the percentage of children who were overweight by the end of the program," Megan said.

"Because the program has shown great potential, we are now conducting a much larger study – a randomised controlled trial. This will involve around 160 participants who will be randomly assigned to an intervention group or a control group."

Megan said early childhood is a critical time for the development of healthy lifestyle practices, which are not only important in physical health, but can also heavily influence cognitive development and social and emotional wellbeing.

"Early childhood is a period of time when lifestyle behaviours such as physical inactivity and healthy eating are established. It becomes more challenging to change unhealthy behaviours as children get older and therefore it is crucial that healthy habits are established in early childhood.

"The influence of parents at this stage is vitally important, which is why this program is parent-focused."

As a dietitian, Megan has too often seen the result of many years of unhealthy lifestyle habits in the form of conditions such as diabetes and cardiovascular disease.

"I became very interested in prevention and where better to start than early childhood, before unhealthy habits become embedded," she said.

"My passion for the area was also inspired by having two children of my own."

If the program is shown to be successful, Megan hopes to implement it more widely. She also hopes to continue her research in this area, specifically looking at further opportunities to use technology-assisted programs.

FRI 19 FEBRUARY 2016

Media coverage - Megan Hammersley

UNIVERSITY OF WOLLONGONG

Executive summary

Feb 8-19 2016.

AM Radio (5 items)

Researchers from the University of Wollongong want to recruit 160 families for na study ...

ABC South East NSW, Bega, 07:30 News, Newsreader 16 Feb 2016 7:36 AM

Duration: 0 min 47 secs • ASR AUD 96 • NSW • Australia • B. UOW - Radio & TV • ID: V00064907147

Researchers from the University of Wollongong want to recruit 160 families for na study in childhood obesity. Megan Hammersley, program organiser, says she is looking for children aged between two and five who are at risk of obesity

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Megan Hammersley, program organiser

News Headlines:...

ABC South East NSW, Bega, Breakfast, Ian Campbell 16 Feb 2016 8:32 AM

Duration: 2 mins 30 secs • ASR AUD 308 • NSW • Australia • B. UOW - Radio & TV • ID: W00064907348

News Headlines:

- There is call for parents to keep tighter control on their children at night following another spate of vandalism at the Bega Recreation Ground.
- The decision to cut the Lone Pine service from Anzac Day commemorations at Gallipoli has been slammed by Peter McMahon, President, RSL Cooma Sub Branch, in the South East. The Department of Veterans' Affairs says the cancellation is because of the potential for extreme weather.
- Monaro Police say the number of people failing to comply with school zone speed limits is not acceptable.
- Local councils across Australia are using glyphosate, a weed killer originally trademarked as Roundup, despite the World Health Organization claiming it probably causes cancer.
- University of Wollongong researchers want to recruit 160 families for a study into childhood obesity.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Garry Arkin, President, Bega Roosters [excerpt]|Megan Hammersley, Early Start Research Institute PhD Student, University of Wollongong [excerpt]

Program Preview:
- Interview with the University of Wollongong about obesity research.

ABC South East NSW, Bega, Breakfast, Ian Campbell 16 Feb 2016 9:24 AM
Duration: 0 min 20 secs • ASR AUD 41 • NSW • Australia • B. UOW - Radio & TV • ID: W00064909384

Program Preview:
- Interview with the University of Wollongong about obesity research.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interview with Megan Hammersley, University of Wollongong, about research into obesity ...

ABC South East NSW, Bega, Breakfast, Ian Campbell 16 Feb 2016 9:24 AM
Duration: 6 mins 23 secs • ASR AUD 786 • NSW • Australia • B. UOW - Radio & TV • ID: W00064909400

Interview with Megan Hammersley, University of Wollongong, about research into obesity and improving the diet of young people. Campbell says the university is recruiting families on the South Coast in an online study that involves obese preschoolers. Hammersley says 23% of children in the preschool age group are overweight or obese. Campbell says some people point to screen time as the reason why children are obese. Hammersley says this is just one contributor. She says parents have busy lives and may not have time to organise physical activity. She says there is misinformation on the Internet. She says sleep can be a factor in the weight of children. She says parents are important role models for children. She says more information about the Time2bHealthy program is on the university's website.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Megan Hammersley, University of Wollongong

University of Wollongong researchers are about to run an online healthy lifestyle program ...

ABC South East NSW, Bega, 12:00 News, Newsreader 16 Feb 2016 12:03 PM
Duration: 0 min 41 secs • ASR AUD 84 • NSW • Australia • B. UOW - Radio & TV • ID: V00064908927

University of Wollongong researchers are about to run an online healthy lifestyle program lasting 11 weeks. The program looks at ways of improving physical activity, reducing screen time and encouraging healthy eating to reduce childhood obesity.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Megan Hammersley, organiser, University of Wollongong

FM Radio (4 items)

News Headlines:...

ABC Illawarra, Wollongong, Breakfast, Melinda James 15 Feb 2016 6:19 AM

Duration: 0 min 40 secs • ASR AUD 82 • NSW • Australia • B. UOW - Radio & TV • ID: W00064886883

News Headlines:
- A Federal Cabinet reshuffle over the weekend has seen two Illawarra politicians move to new jobs.
- Retired people are facing a rise of up to 60% on their public transport costs.
- Researchers from the University of Wollongong want to recruit 160 families for a study in childhood obesity.
- The Illawarra Hawks have their sights on the premiership after winning their regular season.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Researchers from the University of Wollongong want to recruit 160 families for a study on ...

ABC Illawarra, Wollongong, 06:30 News, Newsreader 15 Feb 2016 6:32 AM

Duration: 0 min 43 secs • ASR AUD 88 • NSW • Australia • B. UOW - Radio & TV • ID: 200064887514

Researchers from the University of Wollongong want to recruit 160 families for a study on childhood obesity. Megan Hammersley, PhD student, University of Wollongong Early Start Research Institute (ESRI), says she is looking for children aged between two and five who are at risk of obesity.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Megan Hammersley, PhD student, University of Wollongong Early Start Research Institute (ESRI)

Interview with Megan Hammersley, Early Start Research Institute PhD Student, ...

ABC Illawarra, Wollongong, Breakfast, Melinda James 15 Feb 2016 6:45 AM

Duration: 7 mins 53 secs • ASR AUD 970 • NSW • Australia • B. UOW - Radio & TV • ID: W00064887365

Interview with Megan Hammersley, Early Start Research Institute PhD Student, University of Wollongong, about a University of Wollongong run trial looking to promote healthy weight in preschoolers. Hammersley says they are trialling an online healthy lifestyle program which aims to give parents the tools to be able to implement change in the lifestyles of their family. She says they are looking at preventing childhood obesity and are targeting the younger age group before unhealthy habits become entrenched. Hammersley says throughout the year they are aiming to recruit 160 families.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

Megan Hammersley, Early Start Research Institute PhD Student, University of Wollongong

University of Wollongong researchers are about to run an online healthy lifestyle program ...

ABC Illawarra, Wollongong, 07:30 News, Newsreader 15 Feb 2016 7:33 AM

Duration: 0 min 41 secs • ASR AUD 84 • NSW • Australia • B. UOW - Radio & TV • ID: V00064889317

University of Wollongong researchers are about to run an online healthy lifestyle program lasting 11 weeks. Megan Hammersley, program organiser, says she is looking for children aged between two and five who are at risk of obesity.

Audience

N/A ALL, N/A MALE 16+, N/A FEMALE 16+

Interviewees

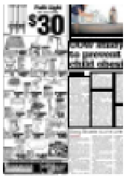
egan Hammersley, program organiser

Newspaper (1 item)

UOW study to prevent child obesity

Illawarra Mercury, Wollongong NSW, General News, Lisa Wachsmuth 19 Feb 2016

Page 8 • 379 words • ASR AUD 1,901 • Photo: Yes • Type: News ItemClassification: • Size: 347.00 cm² • NSW • Australia • A. UOW - Press • ID: 545659308



AN INNOVATIVE University of Wollongong study hopes to beat the battle of the bulge in preschoolers. Researchers are seeking 160 parents with preschoolers who are overweight, or at risk of being overweight, to take part in the Time2bHealthy program.

View original - Full text: 379 word(s), ~1 min

Audience

14,256 CIRCULATION

Keywords

Early Start(1),Institute(1),Research(2),researcher(2),Researchers(1),university(2),university's(1),UOW(2),Wollongong(1)

Online News (1 item)

UOW study to prevent child obesity

Illawarra Mercury by Lisa Wachsmuth 18 Feb 2016 4:30 PM

382 words • ASR AUD 21 • C. UOW - Internet • ID: 545492727

An Australian-first program to target obesity among preschoolers will be trialled in the Illawarra.

An innovative University of Wollongong study hopes to beat the battle of the bulge in preschoolers.

Researchers are seeking 160 parents with...

Read on source website

Audience

3,342 UNIQUE DAILY VISITORS, 39 AV. STORY AUDIENCE

Keywords

Early Start Research Institute(1),University of Wollongong(1)

TV (1 item)

In conjunction with Healthy Weight Week, an online program looking to improve the ...

WIN Wollongong, Wollongong, WIN News, Kerryn Johnston 16 Feb 2016 7:17 PM

Duration: 0 min 48 secs • ASR AUD 1,223 • NSW • Australia • B. UOW - Radio & TV • ID: M00064915561

In conjunction with Healthy Weight Week, an online program looking to improve the lifestyle of preschoolers is being trialled in the Illawarra. A small scale trial was completed a couple of years ago and is now being expanded with researchers calling on Illawarra parents to get involved.

Audience

42,000 ALL, 19,000 MALE 16+, 19,000 FEMALE 16+

Interviewees

Megan Hammersley, UoW PhD Student

19 Feb 2016
Illawarra Mercury, Wollongong NSW

Author: Lisa Wachsmuth • Section: General News • Article type : News Item
Classification : Regional • Audience : 14,256 • Page: 8 • Printed Size: 347.00cm²
Market: NSW • Country: Australia • ASR: AUD 1,901 • Words: 379 • Item ID: 545659308

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UOW study to prevent child obesity

BY LISA WACHSMUTH

AN INNOVATIVE University of Wollongong study hopes to beat the battle of the bulge in preschoolers.

Researchers are seeking 160 parents with preschoolers who are overweight, or at risk of being overweight, to take part in the Time2b-Healthy program.

Lead researcher Megan Hammersley said the 12-week online program aimed to improve children's eating habits, physical activity, screen time and sleep.

It was also designed to help preschoolers reach and maintain a healthy weight, with statistics showing one in four Australian children were overweight or obese.

"The main aim of the program is to provide parents of preschool aged children with the tools, resources and support to make healthy lifestyle changes for their children," she said.

Mrs Hammersley, a dietitian and PhD student at the university's Early Start Research Institute, said research showed only five per cent of Aussie children ate enough fruit and vegetables.

Meantime preschoolers got more than one third of their energy from "non-core foods" such as biscuits, cakes and other energy dense snack foods.

"Childhood obesity is rising partly because people are busy and don't have time to prepare meals, plus the environment has become saturated with convenient and fast foods," she said.

"At the same time there's more convenience in our environment – such as cars and remote controls – and children are spending a lot of time in front of computer screens and on tablets rather than in active play."

Children who were overweight or obese had at least twice the risk of being the same in adulthood – leading to a higher chance of cardiovascular disease, diabetes and other health issues.

"It's important to take preventative measures in childhood, before unhealthy habits become embedded," Mrs Hammersley said.

The program, believed to be the first in Australia to target preschoolers, involves a few trips to the university for measurements and discussions but is mostly completed online.

"It can be hard for parents to get to face-to-face appointments due to travel, cost or childcare for other siblings," she said. "This program allows them to go online at a time that suits them."

For details contact mlh965@uowmail.edu.au


19 Feb 2016
Illawarra Mercury, Wollongong NSW

Author: Lisa Wachsmuth • Section: General News • Article type : News Item
Classification : Regional • Audience : 14,256 • Page: 8 • Printed Size: 347.00cm²
Market: NSW • Country: Australia • ASR: AUD 1,901 • Words: 379 • Item ID: 545659308

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STUDY: UOW researcher Megan Hammersley - pictured with colleague Karen Tonge and her daughter Isla, 5 - hopes a new program will halt child obesity. **Picture: Paul Jones**